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The Journal of HEREDITY

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APRIL, 1925

THE POTATO OF ROMANCE
W. E. Safford

THE TEOPOD MUTATION IN MAIZE
E. W. Lindstrom

HEREDITARY IMPAIRMENT OF HEARING
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RUMPLESSNESS IN THE DOMESTIC FOWL
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A BIOMETRICAL MISCELLANY
A Review

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THE RELIQUES OF FATHER PROUT.

First planting of the Potatoe in Ireland.

LONDON:

GEORGE BELL & SONS.

SIR WALTER RALEIGH

Frontispiece

Legendary introducer of the potato into Europe, depicted in the act of giving potatoes to the Irish. It is quite certain that he did not bring the potato from America. It reached North America from Ireland and did not find its way to Virginia until more than a century after the return of his unhappy colonists.

THE POTATO OF ROMANCE AND OF REALITY

WILLIAM E. SAFFORD

THE early history of *Solanum tuberosum* is obscured by conflicting stories, many of which must be relegated to the sphere of romance. In the United States this plant is commonly called the "Irish potato"; but it is only a potato by analogy, and Irish by adoption. The true, or original, potato is the *Ipomoea batatas* (Figure 2), which we now call "sweet potato," a plant belonging to the Convolvulus, or Morning glory, family; the "Irish potato" belongs to the Solanum, or Nightshade, family, of evil repute, many of whose members have poisonous or narcotic properties. The name potato is scarcely more applicable to it than "pig" to guinea-pig, or "dog" to prairie-dog, yet this is the only name by which it is known to English-speaking people. The French call it *pomme de terre*, or earth-apple; the Spanish *papas*, its original name; the Germans, *Erdapfel*, *Erdbirne*, *Grundbirne*, or *Kartoffel*, the last word a modification of *Tartuffel* or truffle.

The Potato of Romance

For the application of the name potato to *Solanum tuberosum* as well as for the erroneous statements regarding its origin, the responsibility must be charged to John Gerard, who in 1597 figured and described it under the title of "Potatoes of Virginia—*Battata Virginiana sive Virginianorum & Pappus.*" His illustrations (Figure 3) and description show that his plant was indeed *Solanum tuberosum*, but he follows his description with the statement that "it groweth naturally in America, where it was discovered, as reporteth C. Clusius; since which time I have received roots thereof from Virginia, otherwise called Norembega, which growe and prosper in my garden, as in their own native countrie."[1] To this he adds "the Indians call it Pappus," an assertion which would lead one to believe that it was thus called by the Indians of Virginia. In reality the name *papas* was its vernacular name not in Virginia, but in Peru, which, as we shall see later, was its original habitat. As a matter of fact, the potato did not reach Virginia for more than a hundred and twenty years after the publication of Gerard's Herbal. It must have been Gerard's statement which led Thomas Jefferson to declare that "round potatoes" (*Solanum tuberosum*) were found in Virginia when first visited by the English.[2]

It is surprising that Jefferson should have made this mistake; for he may be called Virginia's historian, and he was especially interested in all things pertaining to food plants and their culture. Still more surprising is the mistake of Schoolcraft, one of our most reliable authorities on the history and customs of the American Indians. In an official report published by the State of New York in 1846 he makes the following statement: "the potato was certainly indigenous [to America]. Sir Walter Raleigh in his efforts at colonization had it brought from Virginia under the original name of Openawg. But none of the North American tribes are known to have cultivated it. They dig it up like other indigenous edible roots from the forest, but it has long been introduced into their villages and

[1]The Herball or General Historie of Plantes, gathered by JOHN GERARDE of London, Master of Chirurgerie P. 781. 1597.

[2]Jefferson's Notes on Virginia, in *Writings of Thomas Jefferson*, 8:225. 1884.

JOHN GERARD

Figure 1

He is holding in his hand a flowering branch of *Solanum tuberosum*, which he called *Battata Virginiana sive Virginianorum & Pappas*, pretending to have received from Virginia the tuber from which it was propagated. He must be held responsible for the transfer of the name Potato from *Ipomoea batatas* to *Solanum tuberosum* and for the confusion of the latter with the Openauk of Virginia. Portrait reproduced from his Herbal. 1597.

spread over the Northern latitudes, far beyond the present limit of Zea maize.'"[3]

The persistence of erroneous stories regarding the potato is shown in the following quotation from a recent standard work of reference, under the heading Potato, "Commonly known as the 'Irish, White, or round' potato." "It seems to have been introduced into Europe as early as 1565. Sir Walter Raleigh in 1585 is said to have brought back the potato from a new country. Recent investigations, however, seem to give the credit of introducing the potato into England to Sir Francis Drake in 1586. As *Batatas Virginiana* it was figured and described by Gerarde in 1597. It is probable that these circumstances led erroneously to giving the credit of introducing the potato to Raleigh instead of to Sir John Hawkins." And farther on in the same work, where it is assumed that the potato is really identical with the Openawk of Virginia, appears the following: "The tubers of the wild *S. tuberosum* were small and attracted little attention. Heriot, in his Report on Virginia, describes one plant 'with roots as large as a walnut and others much larger. They grow in damp soil, many hanging together, as if tied on ropes.' The modern potato has been bred so that the hills contain four to six tubers of uniform size, weighing perhaps two pounds.'"[4]

In a publication of more recent date appears the following: "In 1565, Hawkins found potatoes at Santa Fé de Bogotá and carried some thence. . . . It is quite possible that Hawkins carried the potato to North America in 1565, when he relieved the famine among the French on the banks of the River May, now St. John's, Florida, and sailed northward towards Virginia where, in 1584, Heriot describes under the name Openawk what is supposed to be the potato.'"[5]

Now it is quite certain that Sir John Hawkins never visited Santa Fé de Bogotá. Had he done so he might indeed have encountered *Solanum tuberosum*. On referring to his original narrative I find that in 1565, on his first voyage, his ship, the *Jesus of Lubeck*, went for water and provisions to a port called Santa Fé on the coast of what is now Venezuela. There he received from Carib Indians — naked savages who slept in cotton hammocks and were armed with poisoned arrows —"hennes, potatoes and pines." The "hennes" were an indigenous pheasant-like bird commonly called curassow, which the Indians of that region still domesticate. The "pines" were pine-apples "of the bignes of two fistes," the inside of which "eateth like an apple, but is more delicious than any sweete apple sugared." The "potatoes" were what we now call sweet potatoes, "the most delicate roots that may be eaten." These were, after manioc (the roots from which tapioca is derived), the most important food staple of the Indians inhabiting the islands and shores of the Caribbean Sea, a region where *Solanum tuberosum* was quite unknown at the time of Hawkins' visit. Sweet potatoes were encountered by Columbus and his companions immediately after their arrival in the New World and were highly esteemed not only for their delicious taste but for the ease with which they could be propagated and their immunity from the hurricanes which so frequently destroyed the plantations of upright manioc. Columbus never saw a tuber of *Solanum tuberosum*, nor was this plant encountered by Cortez in Mexico.

The identity of Sir John Hawkins' potatoes was recognized by Sir Joseph Banks, who called attention to the fact

[3]Schoolcraft, H. R. Census of the Iroquois. New York State Documents, No. 24, p. 12. 1846.

[4]Bailey's Standard Cyclopedia of Horticulture, 5:2767, 2768. 1916.

[5]Sturtevant's Edible Plants. Edited by U. P. Hedrick, in Report of the New York Experiment Station, New York State Department of Agriculture, 27th Annual Report. Vol. 2, part 2, p. 546. 1919.

that the sweet potato was introduced at a very early date into the Canary Islands and Spain, whence it was imported in considerable quantities into England, long before the introduction of *Solanum tuberosum*. He also pointed to the interesting reputation that the sweet potato enjoyed of possessing the power to restore decayed vigor and added that "the kissing comfits of Falstaff and other confections of similar imaginary qualities with which our ancestors were duped, were principally made up of these and of eringo roots."[6]

The openawk of Virginia, with which the potato was also confused, was described in 1588 by Thomas Heriot, the historian of Sir Walter Raleigh's second ill-fated colony, on Roanoke Island, who published the first accurate account in English of North American Indians and their food-plants. It is quite certain that he never carried a tuber of *Solanum tuberosum* from Virginia to England. His openawk was not a Solanum, but *Glycine apios*, a tuber-bearing leguminous plant not even remotely related to the Solanaceae.

The tubers of *Glycine apios* were an important food staple of all the Indian tribes of Eastern North America from the Gulf of Mexico to the St. Lawrence River. By the English colonies they were called Indian potatoes, bog potatoes or ground nuts. By the settlers of New France they were called *chapelets*, or rosary roots, from their beadlike arrangements on strings. The various tribes of Indians had each its vernacular name for them. *Openawk, openaug, penag* or *penac*, was their Algonquin name, the radical *pen* signifying a round root or tuber, to which was added the plural suffix *auk* or *ac* and usually the demonstrative prefix *o;* so that *penac*, still used by the Canadian Algonquins, signified "round roots, or tubers," and *openauk* of the Southern Algonquins "those-roots."

This name has come down to us in a variety of forms, according to the orthography of early writers. Strachey in his account of the Jamestown Indians called it *ouhpunnauk;* according to Zeisberger, its Delaware name was *hobbenac;* Peter Kalm gives its diminutive form *hopnis* (*hopenis*), which may be translated "those-small-roots." At the time of his visit the Swedish colonists still called it by its Indian name. In his description of the plant he says: "The roots resemble potatoes and were boiled by the Indians, who eat them instead of bread. Some of the Swedes at that time likewise ate this root for want of bread. Some of the English still eat them instead of potatoes. Mr. Bartram told me that the Indians who live further in the country, not only eat these roots, which are equal in goodness to potatoes, but likewise gather the peas which lie in the pods of the plant and prepare them like common peas."[7]

In early accounts of the settlement of New England these potatoes, called ground nuts, were the chief reliance of the colonists in times of scarcity. In the personal narrative of Mrs. Mary Rowlandson, the wife of a clergyman, taken captive by the Indians during King Philip's War, she refers frequently to ground nuts, which she characterizes as the principal wild food-staple of the Indians.[8] They were eaten either boiled, roasted, made into cakes or added to broth of meal made

[6]Banks, Sir Joseph. "An Attempt to Ascertain the Time When the Potato (*Solanum tuberosum*) Was First Introduced Into the United Kingdom." Transactions Horticultural Society of London, 1:8-11. 1805.

[7]Kalm, Peter. Travels in North America. London. 1772 See Pinkerton's Voyages, 13:533. 1812.

[8]"Their chief and commonest food was ground nuts; they eat also nuts and acorns, artichokes, lily-roots, ground beans [*Falcata comosa*, now usually called hog-peanuts] and several other weeds and roots that I know not."—Narrative of the captivity of Mrs. Mary Rowlandson, wife of the Rev. Joseph Rowlandson, who was taken prisoner when Lancaster (Massachusetts) was destroyed in the year 1676; written by herself. In Indian Captivities, by Samuel G. Drake, p. 54. 1851.

THE ORIGINAL POTATO, NOW CALLED SWEET POTATO

Figure 2

Ipomoca batatas. Confused by early writers with *Solanum tuberosum.* Observed first by Columbus, November 4, 1492, and described in his Journal as "Niames (yams) resembling carrots, with a savor of chestnuts." Identified by Las Casas, his contemporary, as "Ajes" or "Batatas." Collected at Santa Fé, on the north coast of South America, in 1565 by Sir John Hawkins, who described it as "the most delicate rootes that may be eaten."

of the bark of a tree."[9] She was sent at times to the woods to dig them and she states that in pursuing the Indians the English soldiers "might track them by their rooting the ground for ground nuts, while they were flying for their lives."[10] She also describes the preparation of corn in the form of toasted meal, identical with the *pinoli* of the Indians of the Southwest and Mexico.

The Abbé Provancher[11] gives the Quebec name of the ground nut as *penac*, without the prefix. The early missionaries of New France, like the settlers of New England, were obliged to resort to the roots when provisions were scarce. It is related that in the winter of 1613 Père Biard, with two companions, went in search of them in the woods near Port Royal. In the narrative it is stated that the roots were quite abundant in some localities, yet scarcely a patch could be found where the savages had not already been digging them, so that most of those they got were small; "and it was necessary to work pretty hard to gather enough for a day's living."[12]

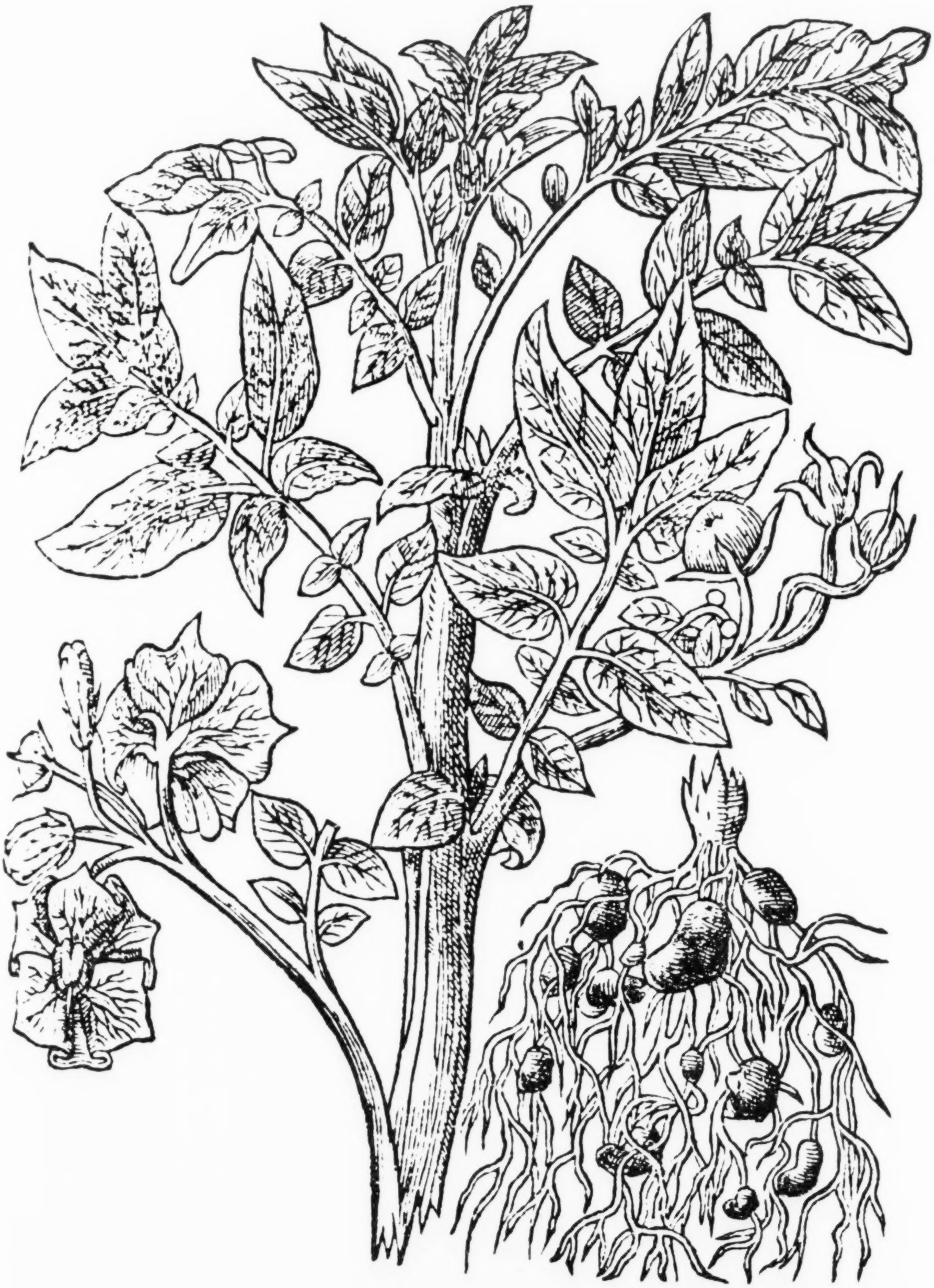
Glycine apios of Linnaeus, or *Apios tuberosa*, as it was called by Moench, is a twining, bean-like plant with alternate, pinnately compound leaves composed of five to seven leaflets, and dense racemes of small purplish brown papilionaceous flowers having a broad reflexed standard and an incurved keel. The pod is a linear slightly curved, many-seeded legume. The tubers, aptly described by Heriot in 1588, "are a kind of roots of round forme, some of the bignes of walnuts, some far greater, which are found in moist and marish grounds growing many together *one by another* in ropes, or as thogh they were fastened with a string. Being boiled or sodden they are very good meate."[13]

In the accompanying illustrations, Figure 4 is the photograph of two flowering branches twining about a grape vine (natural size). It was collected in a "marish" thicket in Virginia, July 31, 1923, by Mr. O. M. Freeman of the Bureau of Plant Industry. Figure 5 is a clump of rootstocks from a single plant, with the tuberous swellings "growing one by another in ropes, or as though they were fastened together with a string." It was collected in Takoma Park, near Washington, D. C., November 13, 1915, by Mr. A. B. Norton.

The confusion between the openauk of Virginia and the papas, or *Solanum tuberosum* of Peru, can be traced to Clusius, who did not suggest that they were identical, but, in a description of the potato, published in his *History of Rare Plants*, after calling attention to the tubers called *papas*, observed by Pedro de Cieza de Leon at Quito, he adds that those roots which the Virginians call *Openauk* were apparently not very unlike them.[14]

Clusius was referred to by Gerard as though he were responsible for identifying the Peruvian *papas* with the Virginian *openawk*. So proud was Gerard of possessing this plant that he caused a portrait of himself to be engraved with a flowering branch of it in his hand. This portrait (Figure 1),

[9]Op. Cit., p. 38.
[10]Op. Cit., p. 53.
[11]Provancher, Abbe L. Flore Canadienne, 154. 1862.
[12]Biard, Rev. Pierre. Relation de la Nouvelle France, p. 213. 1616.
[13]See "A briefe and true report of the new found land of Virginia; of the commodities there found and to be raysed, as well merchantable, as others for victuall, building and other necessarie uses for those that are and shall be planters there; and of the nature and manners of the naturall inhabitants. Discovered by the English Colony there seated by Sir Richard Grenville Knight in the year 1585 . . . at the special charge and direction of the Honorable Sir Walter Raleigh Knight, etc. . . . Directed to the Adventurers, Favourers, and Welwillers of the action, for the inhabiting and planting there. By Thomas Heriot, servant of the above-named Sir Walter, a member of the Colony, and there employed in discovering. Imprinted in London, 1588."
[14]"Quibus non valde absimiles videntur eae radices, quas Virginienses Openawk nominant." Caroli Clusii, Plantarum Historiae Liber quartus, p. LXXX. 1601.



THE FIRST PUBLISHED ILLUSTRATION OF SOLANUM TUBEROSUM

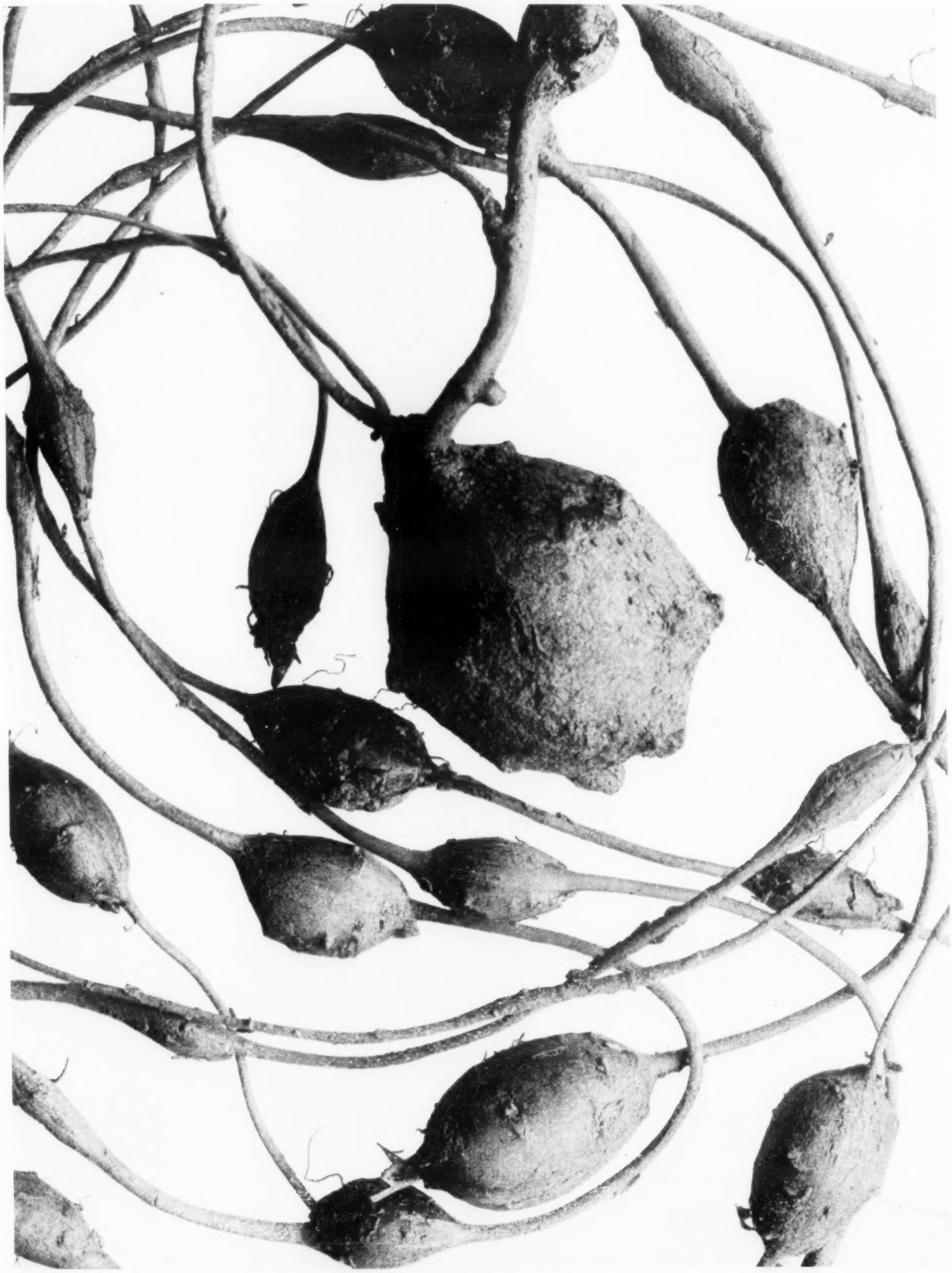
Figure 3

This appeared in Gerard's Herbal in 1597, under the misleading name *Batata virginiana*. Nine years earlier, Clusius, to whom Gerard refers, had received a drawing of this species from Philip de Sivry, under the name *Papas peruanum*.

THE VIRGINIA POTATO OR OPENAUK

Figure 4

Glycine apios, the Openauk or Penak of the Algonquin Indians. A plant of the Bean family, with edible tubers and pea-like seeds, endemic in Eastern North America from Florida to the St. Lawrence river. Encountered by Sir Walter Raleigh's second colony on Roanoke Island in 1586.



OPENAUK ROOTS OR INDIAN POTATOES

Figure 5

Tubers called Openauk by the Virginia Algonquins and Penak by those of Canada. "A kind of rootes of round forme, some of the bignes of walnuts, some far greater, which are found in moist or marish grounds, growing many together one by another, or as thogh fastened with a string."—Thomas Heriot. 1588.

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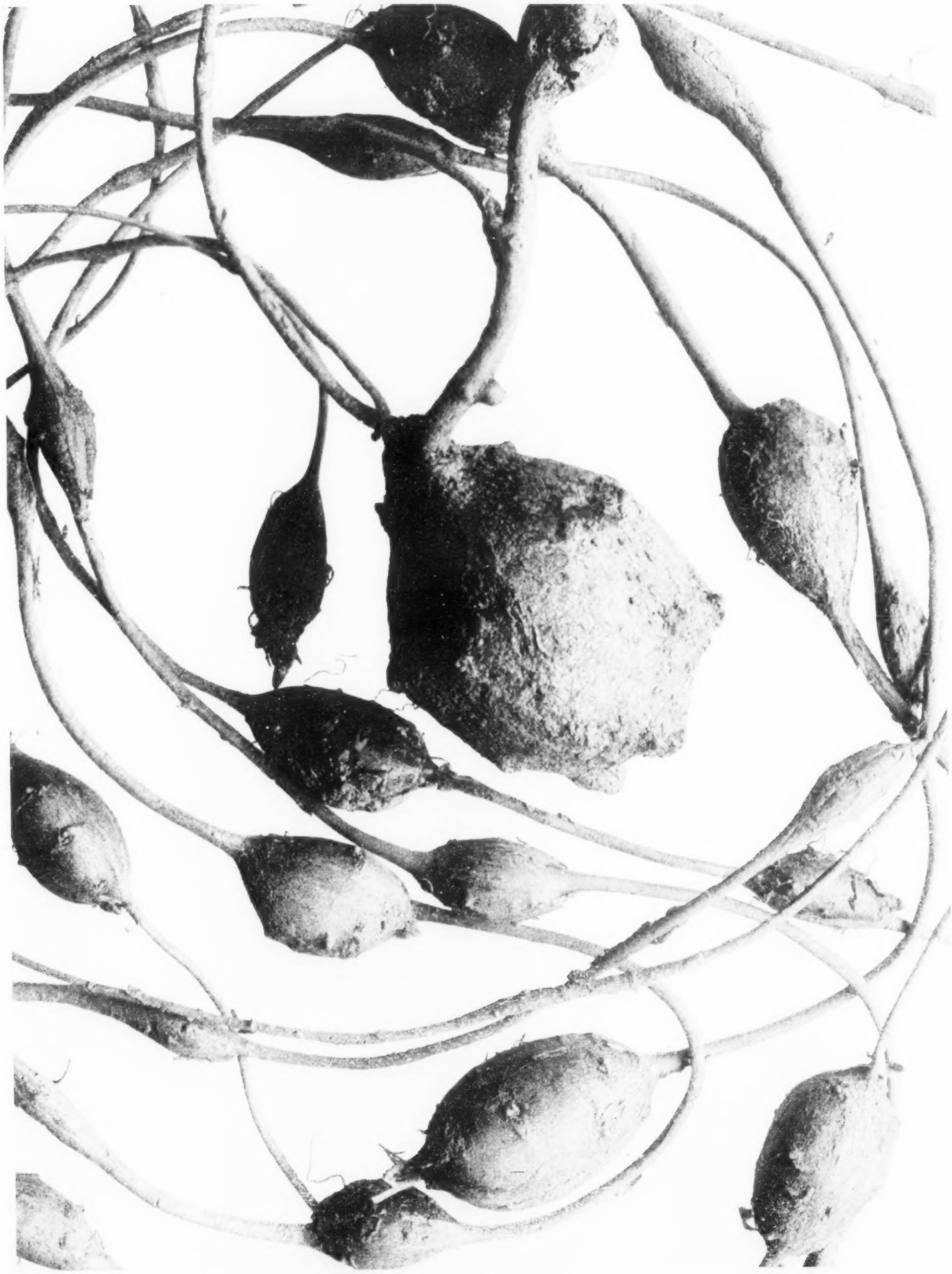

OPENAUK ROOTS OR INDIAN POTATOES

Figure 5

Tubers called Openauk by the Virginia Algonquins and Penak by those of Canada. "A kind of rootes of round forme, some of the bignes of walnuts, some far greater, which are found in moist or marish grounds, growing many together one by another, or as thogh fastened with a string."—Thomas Heriot. 1588.

bearing the date of 1598, was inserted at the end of the preface to his celebrated work.

Gerard's misleading statement regarding the source of his potatoes has been discussed by several writers interested in the origin of cultivated plants. It has been suggested that his illustration of *Solanum tuberosum* may have been prepared on the continent, like many of the other engravings in the Herbal,[15] and it has even been intimated that he concealed the real origin of his tubers in order to "mystify the readers of his Herbal."[16] Whatever may have been his motive, the effect of his account of *Solanum tuberosum*, described and figured under the name *Battata virginiana*, or Virginia potatoes, was to fasten upon a Peruvian plant an English name already belonging to a very distinct species and to mislead posterity into the belief that *S. tuberosum* had been brought to England from Virginia. The persistence of this error has already been noted. One of the writers above referred to, assuming Heriot's openawk to be the potato, quotes his statement that its tubers were found in "moist and marish grounds," notwithstanding the fact that *S. tuberosum* will not grow in moist situations, nor do its tubers resemble those of *Glycine apios*, which "grow side by side, like beads on a string." Indeed there is no species of tuber-bearing Solanum indigenous to Eastern North America; yet the woods are still full of Heriot's openawk.

Among the earliest legends relating to the potato is that recorded in the minutes of the Royal Society of December 13, 1693, in which it is set down that Sir Robert Southwell, the president of the Society, claimed that potatoes were brought into Ireland by his grandfather, who first had them from Sir Walter Raleigh. "This *evidence*," says Sir Joseph Banks, who seems to have accepted the statement as true, "*proves not unsatisfactorily* that the potato was first brought to England either in the year 1586 or very soon after, and sent from thence to Ireland without delay by Sir Robert Southwell's ancestor, where it was cherished and cultivated for food before the good people of England knew its value; for Gerard, who had planted it in his garden in 1597 recommends the roots to be eaten as a delicate dish, not as a common food"; and to this Sir Joseph adds "the name of the root in South America is *papas* and in Virginia it was called *openawk*."

The Raleigh legend can be traced to Dr. Wright of Edinburgh, for whom the botanical genus Wrightia was named; it belongs in the same category with the story of George Washington and the cherry-tree.

In the appendix to the report of the committee of the Board of Agriculture concerning the culture and use of potatoes is the following communication dated March 14, 1795: "In 1584 Sir Walter Raleigh, so celebrated for his worth, his valor, and his misfortunes, discovered that part of America called Norembega and by him named Virginia. Whether the Admiral was acquainted with the potato on his first voyage or whether it was sent to him by Sir Thomas Grenville or Mr. Lane, the first Governor of Virginia, is uncertain. It is probable that he was possessed of the root about the year 1586. He is said to have given it to his gardener, in Ireland, as a fine fruit from America, and which he desired him to plant in his kitchen garden in the spring." Then follows the alleged conversation between Sir Walter and his gardener, which was later attributed to Sir Francis Drake and his gardener, to be quoted below.

This transfer of the honor of introducing the potato from Raleigh to Drake was the result of investigators who found that Sir Walter had not discovered Norembega; had never indeed been in Virginia and that his un-

[15]See W. S. Mitchell, in the Gardeners' Chronicle N. S., 25:533, May 1, 1886.
[16]See B. D. Jackson, in the Gardeners' Chronicle, Third Series, 27:161, March 10, 1900.

A GERMAN MONUMENT TO DRAKE

Figure 6

Sir Francis Drake holding a potato plant with its tubers attached. This monument stands in Offenburg, Baden, in commemoration of his alleged introduction of the potato into Europe.

The inscription on the statue reads: "Sir Francis Drake, introducer of the Potato into Europe, in the year of our Lord 1580." Note the potato plant in Drake's hand and the decorative frieze of potatoes around the base of the statue.

fortunate colony on Roanoke Island had been brought home by Sir Francis Drake. They did not, however, establish the fact that Sir Francis ever had a garden in Ireland or a gardener in any country. There is not a particle of evidence that Sir Walter ever saw a potato in America, and the only opportunity which Sir Francis Drake had to see one was in November, 1578, when, after passing through the Straits of Magellan, he turned northward and received some potatoes from the natives of Mocha, an island in 38° 30′ south latitude on the coast of Chile. From this place he continued northward, looting the coast towns of Chile and Peru and then "sailing along the backside of America to 43° of northerly latitude," after which he returned to England across the Pacific and Indian oceans, rounding the Cape of Good Hope, "the fairest cape we saw in the whole circumference of the earth."

Completing his "renowned voyage, the second circumnavigation of the earth," in November, 1580, he was honored by a visit from his sovereign, Queen Elizabeth, who dined with him on board his ship, the *Pelican* — but there is no record that potatoes appeared on the bill of fare. Indeed it was not until eight years afterwards that he is alleged to have introduced the potato.

Following are the two legends quoted in parallel columns, the second of which I have translated from the work of a German clergyman, Rev. Dr. Carl Wilhelm Ernst Putsche, published in 1819.

The Raleigh Legend

"*Solanum tuberosum*, the common potato of our fields and gardens, was first introduced by Sir Walter Raleigh, who brought the roots from Quito and caused them to be planted in his own garden at Youghal, in Ireland. On the plants arriving at maturity, Sir Walter's old gardener, availing himself of the privileges of his situation, gathered some of the fruit, or 'potato-apples,' as they are now called, and tasted them. Those of our readers who have eaten of this particularly unpalatable and unwholesome production will feel no wonder that the ire of the old man should have been raised. Breaking in unceremoniously on his master's studies, he exclaimed, 'If this is your fine foreign fruit I would not give it garden room, not I!' 'Well,' said Sir Walter, 'if it is as bad as you say, dig it up at once: but if you find any roots worth looking at, bring them to me.' It is, perhaps, needless to say that the roots proved very well worth examining."

The Drake Legend

"The famous English admiral, Francis Drake, deserves the credit for the introduction of the potato into Europe. On his return from Virginia, in 1586, he brought thence the potato with him. . . . Wishing to domesticate it in England, he not only gave some of the tubers to John Gerard, but also handed a part of them to his own gardner, telling him to plant the precious fruit in his garden. . . . When the seed-apples ripened, the gardener tasted them and threw them away in disgust. Bringing a few of these apples to the Admiral he asked sarcastically: 'Is this, then, the famous fruit from America?' The Admiral replied with feigned gravity: 'Very well, if you believe the plant to be worthless, pull it up roots and all before it spoils the garden.' The gardener did as he was bid; but to his surprise, under each plant he found a considerable number of tubers of the same form as those he had laid in the earth the previous spring."

That the Raleigh legend was generally accepted as true is shown by Rev. Francis Mahoney in his celebrated Reliques of Father Prout, the frontispiece of which represents the first planting of the potato in Ireland with Sir Walter, pipe in mouth, as the central figure. (See Frontispiece.) Under the heading of "Father Prout's Carousal," the attention of Sir Walter Scott, who is represented as a guest, is called to the potato. In handing it to him Knapp, the Mayor of Cork, makes the following speech:

"Sir Walter! as it has been my distinguished lot—a circumstance that confers everlasting glory on my mayoralty —to have had the honor of presenting you yesterday with the freedom of the corporation of Cork, allow me to present you with our next best thing, a potato."

Sir Walter Scott: "I have received with pride the municipal franchise and I now accept with equal gratitude the more substantial gift handed me in this capital esculent of your happy country."

Father Prout: "Our round towers, Sir Walter, come from the east, as will one day be proved; but our potatoes come from the west; Persia sent us one, and Virginia the other. We are a glorious people! Two hemispheres minister to our historic recollections; and if we look back on our annals, we get drunk with glory. . . ."

Sir Walter Scott: "I intend writing a somewhat in which Sir Walter Raleigh shall be a distinguished and prominent character; and I promise you the potato shall not be forgotten. The discovery of that root is alone sufficient to immortalize the hero who lost his head so unjustly on Tower Hill."

Father Prout may be excused from accepting this legend as gospel; for he was essentially a man of letters; but we find it to have been accepted also by a professional horticulturist in a monograph on the potato, a copy of which was kindly sent me by the distinguished authority on potato diseases, Dr. Otto Appel, Direktor der Biologischen Reichsanstalt fur Land und Forst-Wirthschaft at Berlin-Dahlem. "Most assuredly," says the author, "do I think that the descendants of Raleigh might be proud of a sprig of the potato foliage on their coat armour, as those of Appel de Kapoesang are of its tubers, with which the Austrian heralds have charged their shields."[17]

Sir Walter's fame has never been perpetuated in the manner suggested above. Worse than this, the credit for its introduction was transferred to Sir Francis Drake and a monument to him was actually erected and still stands in the city of Offenburg, Baden, a photograph of which, received through the kindness of Dr. Appel, is herewith reproduced (Figure 6).

The persistence of potato legends among literary people of romantic temperament is not surprising. They would naturally resent the iconoclastic destruction of a good story; but it is remarkable that in very recent works dealing with agricultural history these tales should be taken seriously. I have already referred to the account of the potato published in a modern cyclopedia of Horticulture. Following is a quotation from a more recent work on the history of American agriculture under the heading "How Potatoes were brought to England."

"Sir Francis Drake in 1585-6 conducted a piratical expedition to the West Indies. He captured several towns and cities and held each until its release was purchased by the inhabitants and also seized and plundered several Spanish ships. For some reason, either fearing capture by the Spaniards, if he returned to Europe by the usual route, or because of sickness among his men as think some authorities, he cruised up the Atlantic coast to return by a more northern route. He found the second Raleigh colony on Roanoke Isl-

[17]A footnote in this little volume calls attention to the fact that Appel de Kapoesang was the first successful cultivator of the potato in Austria. See JOHNSON, GEORGE W., The Potato: Its Culture, Uses and History, p. 3. London, 1847.

and in a destitute condition and took the survivors back to England with him. Drake and Raleigh were old friends. Raleigh was interested in agriculture and had then recently acquired a large estate near Cork, in Ireland. It is a natural supposition that Drake had obtained the potatoes from the Spaniards in the West Indies, where they grow fairly well in the mountainous sections[18] and gave them to Raleigh and that Raleigh gave them a trial on his Ireland farms as has been so commonly stated."

Notwithstanding the author's theory that Drake had obtained Irish potatoes from the West Indies, he once more confuses them with the Virginian *openawk*, included by Heriot in his list of foods of Roanoke Island, declaring that if any man is to be given credit for the introduction of Irish potatoes into European agriculture, the honor should go to Heriot, rather than to Drake or Raleigh.[19]

In a future paper I will speak of the true origin and history of *Solanum tuberosum*.

[18]It has been established without any doubt that *Solanum tuberosum* did not grow in the West Indies until the early part of the 18th century, when it was cultivated in the mountains of Jamaica from tubers imported from Ireland and Lancashire under the name of Irish potatoes.

[19]Carrier, Lyman. The Beginnings of Agriculture in America, pp. 81 and 84. 1923.

An Elementary Book of Eugenics

Wir Und Das Kommende Geschecht, by Dr. med. Hermann Paull. Pp. 175, with 31 illus. Verlag von strecker und Schroeder, Stuttgart, Germany.

This is a good, simple account of eugenics, given in the form of a conversation between a little group of friends. The author, who is a school physician, has included a number of pedigrees from his own experience. He makes a few mistakes, but they are those that are made in nearly all other books on eugenics. As a constructive measure, he lays stress on a scheme for compulsory insurance for childbirth, similar to the compulsory sickness insurance and old-age insurance that are now familiar social measures. It appears likely, however, that such a measure would favor quantity rather than quality of offspring. *P. P.*

THE INHERITANCE OF RUMPLESSNESS IN THE DOMESTIC FOWL

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AMONG the many variations which have been reported and studied in the domestic fowl, one of the most striking and interesting has received but little attention from students of heredity. This variation is rumplessness, or total absence of the tail. Externally the most marked divergence of rumpless from normal fowls (Figures 7 and 8) is the absence of the long and prominent tail feathers which are borne by the small fleshy tail or rump.

When plucked and dissected, the rumpless fowl is found to lack the few vertebrae which support the short tail, the fleshy portion of the rump, the tail feathers, and the oil gland which in most normal fowls is situated at the base of the tail.

Rumpless Breeds

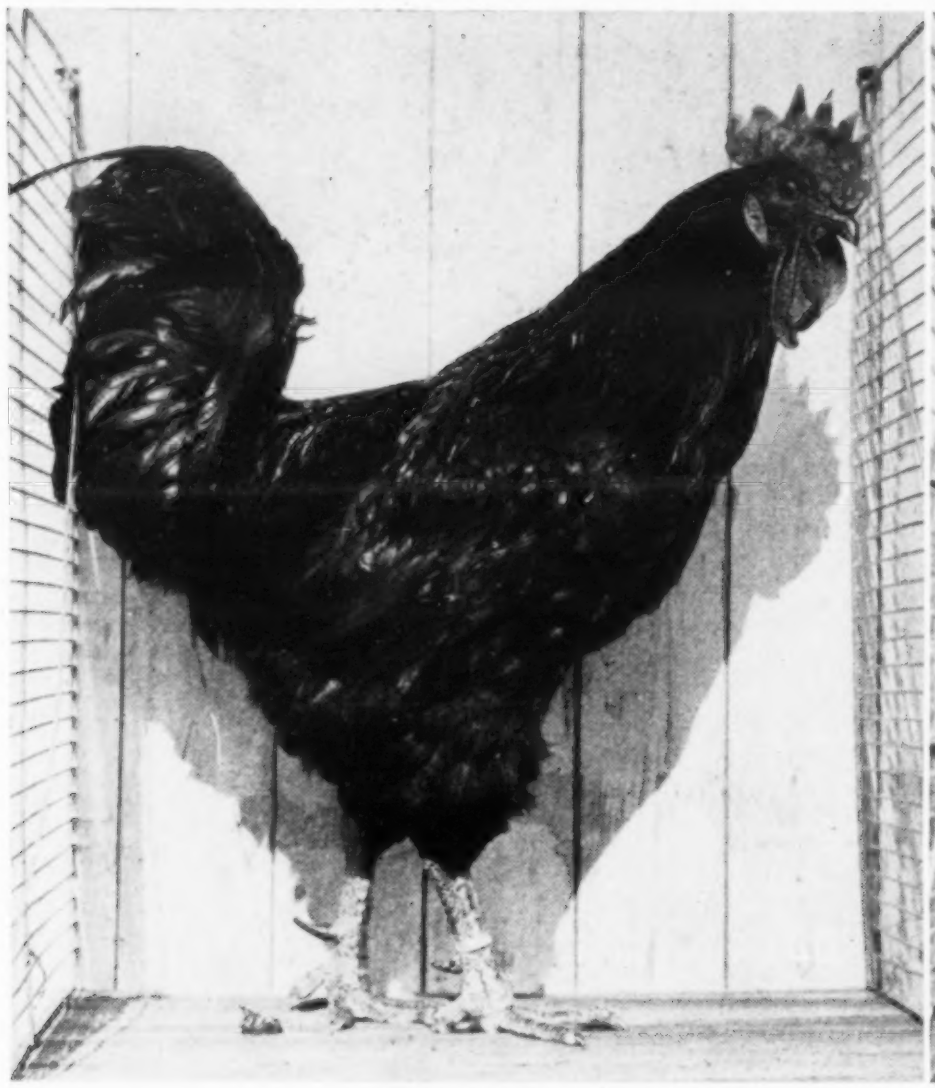
This variation has been known for centuries. According to Tegetmeier (1873) the rumpless fowl was described and figured by Aldrovandus in 1645, under the name of the Persian fowl. Rumplessness has since appeared in many breeds and varieties of domestic fowl, sometimes in isolated instances, and frequently in such a way as to give rise to a variety characterized by rumplessness. Tegetmeier recognized the character rumplessness as a heritable variation which could be (and undoubtedly has been) transferred from one variety to another, resulting in a number of rumpless breeds or varieties. Among these may be mentioned the Rumpless Game Bantams, Rumpless Polish and others. Rumpless fowls are now apparently rare in this country, none having been exhibited in the recent large poultry shows at New York or Boston. It is difficult to decide whether any of these so-called rumpless varieties breed true to the rumpless condition, since there are almost no references to this point in the recent literature. Darwin's[4], Tegetmeier's[8], and Duerigen's[5] notes indicate that most strains of rumpless fowls produce some tailed offspring.

Recently a new rumpless variety, the Auraucana fowl, has been reported from the western coast of South America. Professor Castello[1] who first brought this peculiar variety to public notice reports that it has been bred for many years by the Auraucana Indians of Chile and has appeared recently in other South American countries. It differs from other domestic fowls not only in the absence of tail and rump, but also in possessing peculiar tufts of feathers near the ears, and in laying blue eggs. Castello has assumed on rather slender evidence that the Auraucana breed is descended from fowls indigenous to South America, and thence owes its origin to a wild form distinct from that Asiatic type from which domestic fowls of Europe are descended. One is more inclined to agree with Robinson[7], however, that the peculiarities of the Auraucana fowl are the results of artificial selection and of fortuitous variations occurring in fowls introduced from Europe. Whether this variety breeds true to rumplessness is not reported, although the descriptions and photographs indicate that rumplessness is an essential part of the breed description.

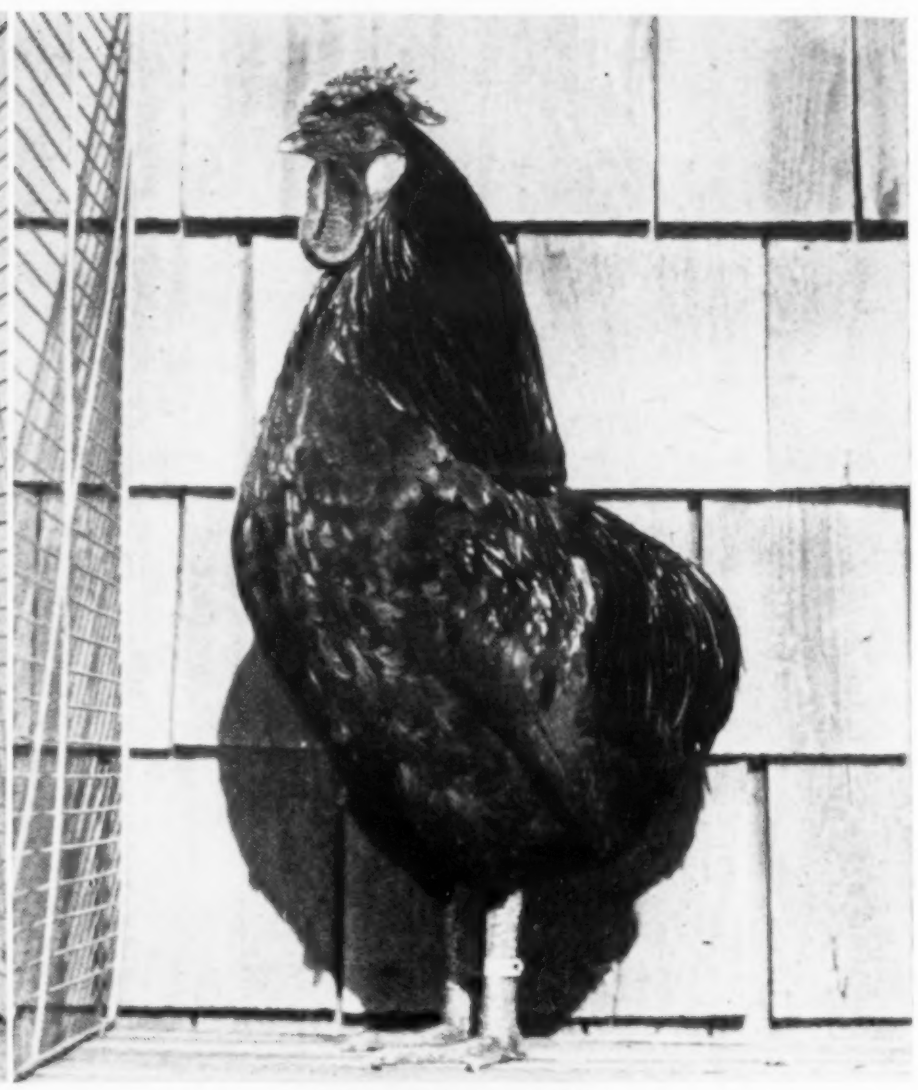
Inheritance of Rumplessness

In addition to the occurrence of rumplessness as a breed or varietal

*Contributions in Genetics No. 33.



Normal ♂

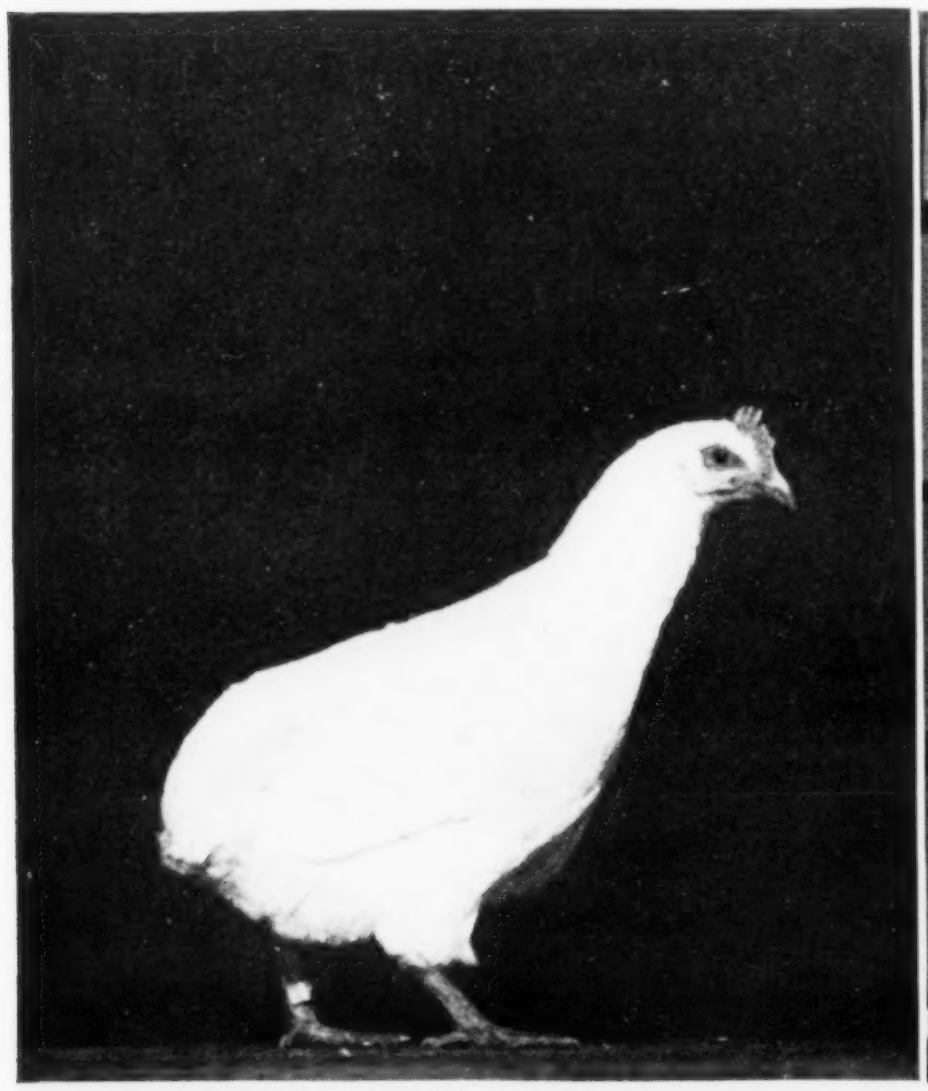


Rumpless ♂ 334

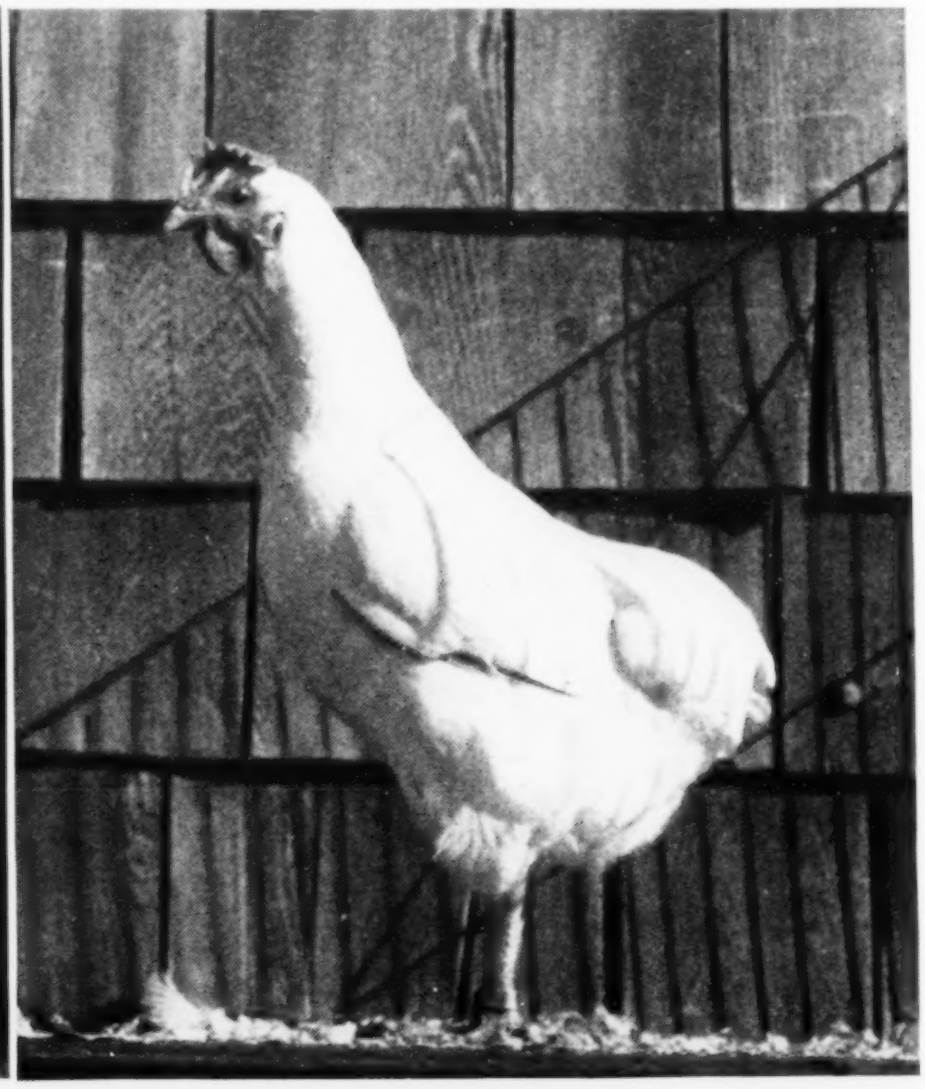
RUMPLESS AND NORMAL COCKS

Figure 7 Figure 8

A normal tailed cock is shown for comparison with the rumpless. In the rumpless fowls several of the vertebrae are missing, as well as the oil gland and some of the muscles. Hereditary rumplessness is a mendelian character, dominant to normal development of the tail. There is also an accidental type of rumplessness which looks the same but it is not inherited.



♀ 962—Acc.



♀ 773—Gen.

GENETIC AND ACCIDENTALLY RUMPLESS HENS

Figure 9

This pullet was one of two rumpless chicks which were found in a farm flock of about a thousand pure bred white Leghorns. Such sporadic cases of rumplessness are probably not hereditary.

Figure 10

A true rumpless hen, offspring of a black rumpless hen by a normal white Leghorn male. Rumpless chickens of many colors and patterns have been reared and even rumpless breeds are recognized.

trait, in which case we may be fairly certain that it is a heritable character, occasional rumpless fowls are known to appear sporadically in many flocks of normal tailed fowls with no evidence that rumplessness has been introduced by crossing. Thus Davenport[2] reports that in 800 chickens bred by him from normal stock, there appeared two rumpless ones. At this station also occasional rumpless chickens are hatched from normal stock which has been bred pure for many generations. Reports from farmers and poultrymen indicate that such rumpless chickens may arise, usually with great rarity, in tailed stock of many varieties.

The questions then naturally arise: Do these occasional rumpless fowls which are produced by normal tailed parents represent new mutations, reappearances by segregation of a recessive rumplessness or are they non-heritable variations occurring at random with regard to ancestry? What is their relation to the rumpless character as found in rumpless varieties?

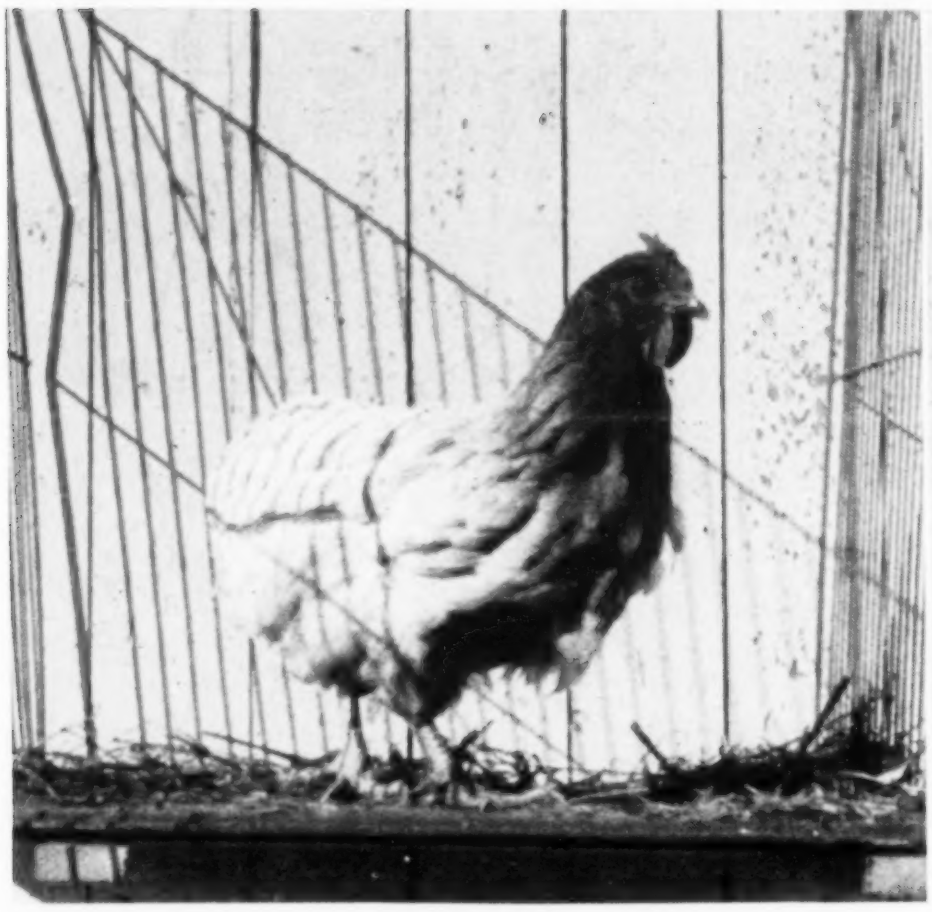
There is also the interesting and not completely solved problem of the inheritance of the anciently known rumpless character which from its occurrence in varietal form is known to be heritable. Davenport[2 3] who was the first geneticist to report experiments with rumpless fowls, concluded that rumplessness was probably due to a dominant Mendelian factor. One rumpless male purchased from a breeder of rumpless fowls produced equal numbers of rumpless and normal chicks when bred to tailed fowls. He was apparently heterozygous for a dominant factor for rumplessness. Another male from the same breeder, when bred to tailed fowls produced no rumpless offspring in the first or the second inbred generation. Meantime two rumpless birds, a male and a female, had appeared in his normal tailed stock. These when mated together produced twenty-four normal chicks and one without tail which died early. The rumpless male was mated with his normal daughters and the progeny inbred, but no more rumpless chickens were produced. In order to explain the contradictory behavior of what was apparently the same trait, Davenport was led to suppose that rumplessness was, as was evident in the first case, a dominant trait but that it varied in potency, so that it did not produce in all cases the characteristic absence of the rump, but (in one case) a few birds with rumps smaller than normal.

Davenport has provided the only data by which this hypothesis might be tested, and although his single case of a monofactorial segregation of rumplessness is good evidence that the character is probably a dominant, it is not sufficient to form the basis for any explanation of the cases in which rumplessness did not reappear in the progeny. It was decided then to obtain new data on the inheritance of rumplessness and the following is an account of the first results of this investigation.

After some search, we finally succeeded in obtaining early in 1922 a rumpless male and two rumpless females from Everett Reeder of Oregonia, Ohio.* These had been kept as pets under the name of "Bunties" and were said to have been descended from rumpless parents. In color and size they were varied and apparently contained the blood of several American varities. We obtained enough chickens from these birds to assure ourselves that the rumpless character in this case was inherited as a dominant trait. In 1923 we again obtained a rumpless cock and three rumpless hens from Mr. Reeder (Figures 8, 11, and 13). Our present stock of rumpless fowls is descended from four of these birds.

Our first experiment consisted in crossing the rumpless males and females together in order to increase the stock. The results of these matings are given in Table I. There resulted nine rumpless chickens and three normals. Each mating produced one nor-

*We are indebted to Mr. H. W. Jackson of the *Reliable Poultry Journal* for help in obtaining these specimens.



♀ 536—Gen.

♀ 337—Acc.

TWO TYPES OF RUMPLESSNESS

Figure 11

A blue rumpless hen of the genetic type. There is no satisfactory evidence that any of the rumpless fowls so far obtained have been homozygous for rumplessness.

Figure 12

This hen appeared in a flock of Dark Cornish fowls at the Connecticut Agricultural College. By normal males she produced thirty chicks, all normal. The absence of the tail was probably due to an accident in development, and the abnormality is not inherited like true rumplessness.

The Aurancana fowl from South America, which has received considerable publicity recently, is said to be rumpless.

mal chicken, indicating that the parents were probably heterozygous in a dominant factor for rumplessness.

We soon discovered, however, that rumpless fowls mated together produced very few fertile eggs. Less than twenty per cent of the rumpless eggs were fertile as compared with eighty to ninety per cent fertility in other stocks under the same conditions. A large part of this infertility appeared to be due to purely mechanical causes. The rumpless males seem frequently to be unable to complete copulation, because of the absence of the tail which in normal cocks serves as a balancer and an aid in copulation. The females had very heavy fluff about the cloaca and they seemed also to be somewhat handicapped in copulation by the absence of the tail and its muscles. We, therefore, cut away all feathers from the region of the cloaca and mated the rumpless females with normal males. We obtained somewhat better fertility, but even in these matings, only 46 out of 205 eggs set were fertile. It was noticed, however, that some of the rumpless females produced as many as 50% of fertile eggs, while others have never produced a fertile egg in two years, even when mated with tailed males.

The matings of fertile rumpless females with tailed males and a few fertile eggs obtained from the reciprocal cross provided a test of the genetic constitution of the rumpless parents. The results of these matings are given in Table II and in Figure 10. These tests show that each rumpless fowl, including the three originally purchased, produced, when bred to normal mates, both rumpless and normal chicks. There can be no doubt that all were heterozygous. The ratio of rumpless to normal chickens resembles the ratio of 1 rumpless: 1 normal which would be expected if the rumpless parents were heterozygous in a dominant

factor for rumplessness. The rumpless progeny are, however, in excess. Records on the condition of the rump of nine chicks from female 773 were not made when the chickens died from disease, but it is probable that most of these were normal. If so the ratio would approach much nearer to equality.

In agreement with this is Davenport's result[3] from one rumpless male, which by normal hens produced equal numbers of rumpless (28) and tailed (27) chickens.

It is probable that a single dominant factor distinguishes rumpless from normal fowls. In the few data available, there is no satisfactory evidence that the homozygous rumpless condition has been obtained. Of five genetically rumpless fowls tested by Davenport, three were heterozygous, while the remaining two produced respectively four and nine rumpless chicks when bred to rumpless mates. The test on the latter can not be regarded as sufficient. Of the rumpless tested in the present study, all eight have proved to be heterozygous. Four of these were descended from matings of rumpless by rumpless and any or all of these might, theoretically, have been homozygous. It will remain for future work with rumplessness to determine whether the homozygous condition of this character is viable. Most rumpless fowls obtained by purchase may be expected to be heterozygous for the reason that it is easier to obtain rumpless chicks from crosses of rumpless by normal than from pure rumpless matings because of the better fertility of the crossed matings.

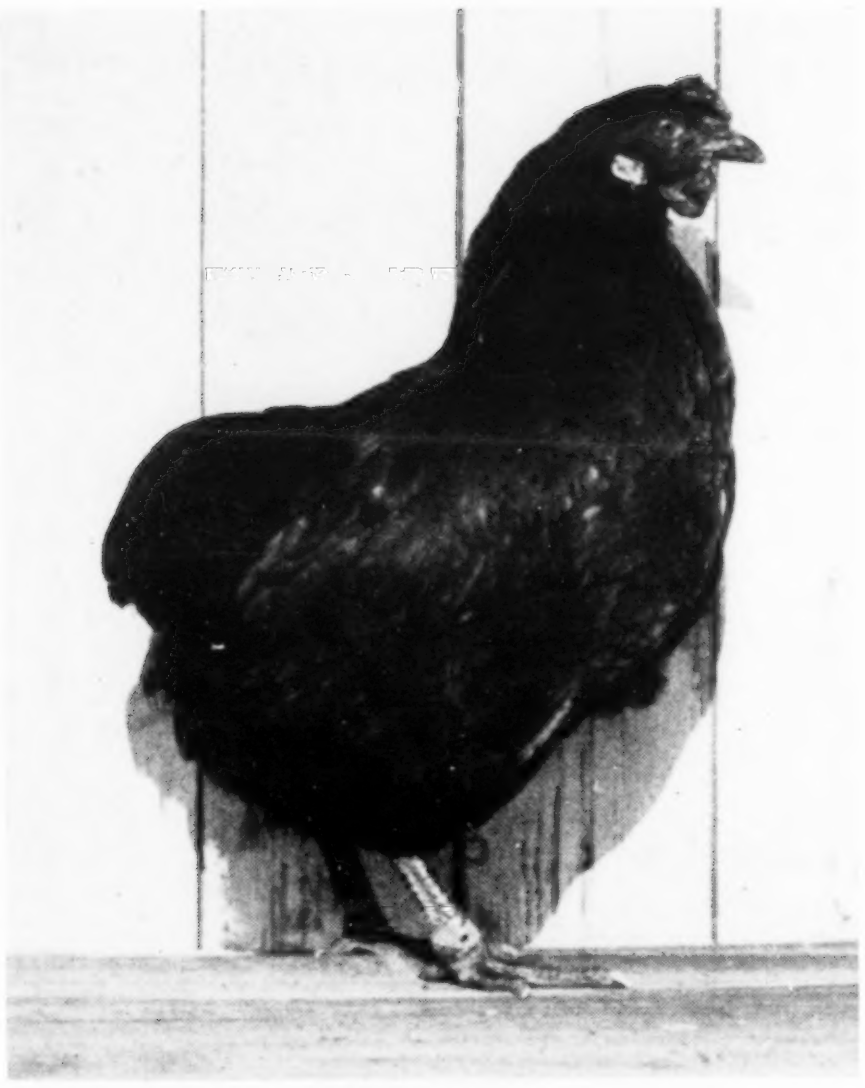
Accidental Rumplessness

Several times in the course of breeding experiments with normal tailed fowls at this station, rumpless chickens have been noted in the progeny of tailed parents. Among 6257 chickens observed by the writer, hatched from the White Leghorn stock of this station which has been bred with no addition of foreign blood since 1915, there have been noted six rumpless chickens. Each rumpless came from a different mother and they are distributed, as to time of hatching, over four years: two each in 1920, 1921 and 1924. The last four rumpless chickens, those of 1921 and 1924 were noted as having a peculiar short white down, with reddish hairs distributed among the down feathers.

Unfortunately all of these chickens died before they were a month old and were not preserved so that we are unable to give any further details concerning the peculiar down structure and color which appeared to be correlated with rumplessness. The first two rumpless chickens (1920) were not recorded as having this peculiar type of down, although since this was my first experience with chickens it may have passed unnoticed. These two chickens lived and became rumpless females which produced no fertile eggs. One other rumpless female, hatched from the same stock in 1919, but not observed as a chick (by the writer) was bred to a normal male during two seasons but produced only four fertile eggs of which two hatched and produced normal chickens.

In other experiments on the inheritance of color we have records of 3913 chickens observed (exclusive of about 3000 chicks hatched in mass experiments in which each chick was not carefully handled) of which four were noted as rumpless, one in 1921 and three in 1924, all from different and unrelated parents of mixed breed. The first, a male, died before it was mature, while of the other three, two are females and one is a male, not yet mature.* Altogether, then, we have

*One of these rumpless chickens had no true down when hatched. Its body was covered with small papillae, possibly containing abnormal down feathers which had not erupted. The chick remained completely naked until the appearance of definitive plumage, which was apparently normal. The other rumpless chickens were not noted as having abnormal plumage.



♀ 336—Gen.

A TRUE RUMPLESS HEN

Figure 13

When bred to a cock with a normal tail she produced equal numbers of normal and rumpless offspring.

observed the rumpless variation in ten out of 10,170 chickens. The data are sufficient to establish the great rarity of this sporadic appearance of rumpless chickens from normal parents. The distribution of this type of rumpless variation with respect to parentage and sibs indicates that it is probably not due to recombination or segregation of recessive genes. The four rumpless fowls from crossbred stock occurred in litters containing 43, 68, 4, and 6 normals respectively. The six white Leghorn rumpless chicks occurred in litters of 27, 22, 19, 14, 9, and 9 normals respectively. We have from the above cases no sufficient test of the genetic nature of this type of rumplessness.

In 1921, a single rumpless chicken was hatched from the pure-bred Dark Cornish stock of the Connecticut Agricultural College and was kindly given to the writer by Prof. D. E. Warner. This proved to be a female and as an adult (Figure 12) was indistinguishable as regards rumplessness from the fowls of our rumpless strain. When bred to a normal tailed fowl, this rumpless hen produced thirty chickens, all normal. An F_2 generation has not been bred owing to the death of all of the male F_1 offspring. The test is sufficient to show, nevertheless, that the rumplessness of this hen is not genetically the same as the apparently similar character in our rumpless strain. By a heterozygous rumpless male of our strain this hen has produced six rumpless and three normal chickens, so that she appears to have the recessive normal allelomorph of dominant rumplessness in spite of being herself rumpless.

Before concluding this account of sporadic cases of rumplessness in normal stock, mention must be made of a number of chickens hatched in 1920 from eggs shipped from Pittsfield, Massachusetts, by a breeder of White Leghorns. Out of fifty-one chickens hatched from this shipment, eight were recorded as rumpless. The record was made when the chickens were half grown, and while I was yet unfamiliar with the characters of fowls so that full credence should not be placed in the record. However, it is probably valid, and may indicate that some flocks may be more likely to produce rumpless chickens than others, or that conditions of shipment (shaking, cold, etc.) may increase the likelihood of a disturbance in development resulting in rumplessness.

Discussion of the Genetic Data

What appear to be two genetically distinct types of rumplessness have been studied experimentally. The first, which may be called dominant or genetic rumplessness appears to be due to a single factor determining the non-development of the rump. Each rumpless fowl of this type which we have bred has had at least one rumpless parent. The data indicate that segregation takes place probably in monohybrid fashion, although there has been noted an excess of rumpless offspring arising from the

mating of heterozygous rumpless by normal.

In calculating the proportion of rumpless and normal chickens arising from crosses of heterozygous rumpless with fowls pure for the normal allelomorph of rumplessness, the progeny of the accidental rumpless female (which bred like a normal) by a rumpless male must be taken into account. When the offspring of the latter cross are added to those of Table 2, the total progeny are 39 rumpless to 26 normal. This is a serious departure from the 1:1 ratio expected, but in the small numbers involved, is still within the limits of sampling. A more complete test with larger numbers is planned.

The second type which to all appearances is identical with the first, appears sporadically in stocks of normal fowls, with a rate, for our stocks, of about one rumpless per thousand chickens. I have called it sporadic or accidental rumplessness. Data on the distribution of this variation, and one breeding test, indicate that it is probably not inherited. Davenport apparently also tested two rumpless fowls of this type and obtained from them only normal offspring with the exception of one chick which died young, recorded as rumpless. This may have been itself a sporadic rumpless or an error in record, for the rumpless father when bred to normal females produced in F_1 only normal chicks and in F_2 no rumpless appeared in forty-nine chickens, thus eliminating the possibility that this type of rumplessness was recessive.

As an hypothesis wherewith to reconcile these two sets of facts, I suggest that rumplessness in fowls may be due to two distinct sets of causes, (1) a gene variation giving rise to the monofactorial dominant type of rumplessness, (2) an accident in embryogeny which arrests the development of the anlage of the caudal vertebrae and tail at an early stage. This type according to Davenport's and the present data, is probably not inherited. Such accidents, resulting in non-heritable variations, are not unknown in fowls. A striking defect of the sternum in a fowl was shown in a recent number of this JOURNAL[5] to be non-heritable; while Davenport[3] (1909) has recorded the case of a wingless cock which when bred to normal hens produced 130 normal offspring. Other and similar cases of non-heritable variations are known to poultrymen and to students of breeding. The peculiarity of the present case is that a non-heritable variation should duplicate so closely the appearance of a heritable one.

A morphological comparison of the two types of rumplessness with the normal fowl has been made and will appear shortly in this JOURNAL.

TABLE I—Matings of Rumpless Fowls *Inter se*

Mother		Father		Offspring					
				Rumpless			Normal		
				♂	♀	?	♂	♀	?
336[a]	Rumpless	334[a]	Rumpless	2	-	-	-	-	1
773[c]	"	539[a]	"	3	2	-	-	1	-
538[a]	"	539[a]	"	-	-	2	-	-	1
			Total	9			3		

TABLE II—Matings of Rumpless Fowls with Normals

Mother		Father	Offspring	
			Rumpless	Normal
336[a]	Rumpless	Normal	4	5
415[b]	"	"	5	2
409[b]	"	"	4	2
773[c]	"	"	11	8
Other rumpless fowls		"	4	2
Total			28 (8♂ 5♀ 15?)	19 (4♂ 3♀ 12?)
Normal	334[a]	Rumpless	3	3
Normal	539[a]	Rumpless	2	1
Total.			5 (1♂ 4♀)	4 (2♂ 1♀ 1?)
Total rumpless × normal matings Expected (one factor segregation)			**33** 28	**23** 28

[a] =Purchased, [b] =from cross of ♂ 334 × normal, [c] =from cross of ♀ 415 × normal.

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Laboratory Manual of the Foetal Pig, by W. J. Baumgartner, Associate Professor of Zoology in the University of Kansas. Pp. XII+56. The MacMillan Company, New York.

This laboratory manual makes available to students of comparative anatomy an excellent guide for the dissection of the foetal pig. Twelve years of experience with such material has convinced the author that the foetal pig offers unusual conditions for the study of the circulatory, digestive, nervous and urino-genital systems in mammals. The indistinctness of the muscles and the lack of development of the bones render the material unsuitable for the study of muscles and the skeleton. These disadvantages are compensated, however, by the greater ease with which the nervous and circulatory systems may be dissected.

Directions are given for the study of the external characters, the viscera, the nervous system and the organs of special senses. H. C. M.

HERITABLE CHARACTERS OF MAIZE

XVI—A New Dominant Hereditary Character—Teopod*

E. W. LINDSTROM
Iowa State College

WITH the exception of the well-known pod corn, there have been reported no hereditary characters in maize that show the phenomenon of dominance towards "normal" corn. Obviously we must exclude from consideration color characters of stalk, ear or kernel, for in these cases we are not certain as to what the normal or original color is. To nature it may have been one color, to the Indians another, and to the corn-belt farmer it is still another. Morphologically, however, all the known variations from "normal" corn are recessive in inheritance (with the exception of pod corn). Such variations include the liguleless condition, tassel-seed, tassel-ear, the many types of dwarfs endosperm defects, zig-zag stalks, and seedling deformities like slashed, spear and others.†

From the evolutionary standpoint it is not surprising that so few of the dominant defects have survived. In fact it is remarkable that pod corn has lasted for so long a time. Perhaps mankind has kept this dominant variation alive because of its unusual appearance. Certainly it could not survive a real struggle for existence over any long period of time in competition with ordinary corn. It is, of course, highly probable that pod corn has arisen as a mutation more than once in the evolutionary history of maize, and hence it occurs today despite the fact that it has little survival value.

A similar deviation from type is reported herewith, one that exhibits dominance in inheritance. From all known records it must have arisen as a mutation, since it is even less well adapted for survival in nature than is pod corn. This new variation has been dubbed "Teopod" from its resemblance both to teosinte (*Euchlaena mexicana*) and to pod corn (Figure 14).

Description

Teopod has two general, outstanding characteristics. First, its leaves are extremely narrow, and the plant suckers profusely, like teosinte. The stalks are covered with a noticeable wax or bloom. Second, the kernels are covered with long glumes, often longer in proportion than those of pod corn. There is a noticeable proportion of the glumes containing two well-developed kernels. Such a pair of kernels enclosed in these long glumes may be side by side or one behind the other. Often only one kernel is enclosed, and rarely three are included in the same set of glumes. Ordinarily the lower flowers are completely sterile.

The staminate inflorescence is characteristically unlike pod corn. In fact there is very little tassel development; at most a solitary rachis bearing functional anthers (Figure 15). Accordingly Teopod is self-pollinated only with great difficulty.

The pistillate inflorescence is peculiar. Even on the best developed plants the podded ears are small, bearing less than a hundred seeds. However, there are often a number of these ears on the long, branching ear-stalks. All of the ears have a distinct cob, being un-

*Paper No. 6 from the Department of Genetics, Iowa State College, Ames, Iowa.

†Since this paper was sent off for publication an article by Kempton (1924) has appeared describing a dominant mutation involving chlorophyll color. KEMPTON, J. H.—A dominant lethal chlorophyll mutation in maize. *Jour. Agric. Res.* 29: 307-309. 1924.

TEOPOD (LEFT) AND NORMAL CORN (RIGHT)

Figure 14

Teopod is characterized by its extremely narrow leaves, by a bloom or wax on the stalks, and by its peculiar podded ears. It probably arose as a dominant mutation of a single, Mendelian gene.

like teosinte in this respect (Figure 16).

In some of the intermediate types of Teopod, the ears are better developed, and only the lower half of the ear bears the long glumes, while on the upper half the kernels are exposed although the glumes are visible. These intermediate types are always the ones with the best tassel development (Figure 15).

There is a tendency for proliferation of the upper leaves and sheaths of Teopod.

INTERMEDIATE TYPES
Figure 15

Single stalks of the more intermediate types of Teopod showing tassel and ear development in the best stages.

Origin

A sample of seed from a Teopod plant was given the writer about four years ago by Mr. E. D. Holden, of the Wisconsin Experiment Station. He obtained it from a farmer, Mr. P. A. Hemmy, at Humbird, Wisconsin. Its history in the hands of the latter is best described by quoting from a letter written by Mr. Hemmy as follows:

"Relative to the origin of the freak corn I sent you, I will say that I discovered a stalk of corn in my field corn that had this peculiar tendency. I saved about twenty kernels and planted them, and two of the stalks showed this tendency the second year, while the rest of the stalks produced normal corn. The following year I had almost one-half that showed this tendency, and

EARS OF TEOPOD MAIZE

Figure 16

Showing the variation in the expression of the character, the ear on the right not having its tip covered by the long glumes. Frequently there are several ears on the long branching ear-stalks, as in the central group shown here.

a year later almost two-thirds showed this tendency. It was then I sent you and the county agent a sample of the corn."

Obviously Teopod must have arisen as a sport. As far as can be determined, it has not been described in the literature of maize; nor would it have been developed and carried on by any breeder, since it is practically worthless from a commercial standpoint.

It is, of course, conceivable that Teopod may have had its origin as a selection from an earlier corn-teosinte cross, and may have been mixed with commercial seed in some manner. This is extremely improbable because all known selections from previous maize-teosinte crosses do not segregate sharply from normal corn on being hybridized, as does Teopod. Thus all evidence seems to point towards an origin by mutation in recent years. That a single mutation could so have changed the morphological structure of the maize plant is indeed remarkable.

Inheritance

Teopod behaves in inheritance when crossed with normal maize, as a simple dominant. Like pod corn, it apparently is semi-lethal in the homozygous (dominant) condition, because in every cross with normal corn, a heterozygous plant has invariably been chosen. Undoubtedly some of the extremely developed Teopod plants on which the ears are practically all glumes and no tassel is formed, may be considered as the homozygous condition. Of this one cannot be certain, since self-pollination is extremely difficult, in fact impossible with most forms of Teopod. All of the data reported herewith arose from crosses with normal corn pollen.

When Teopod is fertilized with normal corn pollen, it gives a fairly sharp segregation in the progenies therefrom, of approximately fifty per cent Teopod and fifty per cent normal plants. The classification in such progenies proved to be reasonably certain, and indicates that the Teopod complex acts as a unit in inheritance, with only small limits of variation. The experimental data available thus far are arranged in Table I. This table includes not only the progeny of guarded pollinations but also of open-pollinations.

In the four progenies from guarded pollinations no difficulty was experienced with intermediate-type plants. The results in these progenies were extremely suggestive of a single genetic factor difference between Teopod and normal corn. The parental Teopod plants in each case must have been heterozygous, *Tp tp*, to produce the 1:1 ratio which was so closely approximated.

That normal corn is recessive to Teopod seems to be conclusively proved by the progenies from five self-fertilized normal plants occurring in segregating progenies. These five gave ninety-seven plants, all strictly normal.

The numbers of the individual progenies in Table I are not sufficiently large to determine whether Teopod is linked with sugary endosperm as is pod corn. In the cross with White Flint there is a strong suggestion of linkage with yellow and white endosperm. Tests for linked inheritance are under way, but at least another season's work is necessary.

Among the progenies from open-pollinated Teopod plants the 1:1 ratio is maintained surprisingly well. This is not strange, since little self-pollination is possible, the Teopod plants rarely producing any pollen. Accordingly these plants must have been pollinated by normal pollen to a large degree.

Conclusion

A new type of maize called Teopod, from its resemblance to teosinte and pod corn, proved to be inherited as a simple dominant character over normal corn. Its history points to an origin by mutation in recent times, since it has little survival value, and especially because its mode of inheritance is distinctly unlike that of known corn-teosinte hybrids. Being a dominant hereditary character, it could not have been

latent in the maize species. One must conclude that is could only have arisen as a mutation.

The most surprising feature of these studies with the Teopod type was the sharpness with which it segregated from normal corn in the hybrid generations. Here is a single, dominant gene that is responsible for great morphological changes (width of leaves, suckering habit, presence of wax on stalks, and new pistillate and staminate inflorescence). It affords an excellent illustration of the profound changes that may be wrought by a single hereditary factor that follows Mendelian inheritance. Surely no one can maintain that Mendelian genes are always superficial in nature; nor that a gene mutation is likely to cause an insignificant change in the species. In fact there is sufficient difference between maize and Teopod to represent a species separation on the superficial grounds of appearance.

It is highly improbable that Teopod is the result of abnormal chromosome behavior because of its simple hereditary performance. Certain tests for linked inheritance that are now under way should afford further critical evidence on this point. Nevertheless cytological observations are necessary and may prove to be of interest.

A supply of seed from Teopod plants is now available, and samples will be sent to any investigators who may be interested in this peculiar type of corn.

TABLE I—Progeny from Various Crosses and Open Pollinations Involving the Dominant Hereditary Character, Teopod.

Parents	Character of seed planted	Progeny		
		Teopod-type	Normal	Intermediate
Teopod × Evergreen Sweet	Starchy	4	5	
	Sugary	4	7	
Teopod × Golden Bantam	Starchy	2	6	
Teopod × White Flint	Yellow	4	10	
	White	4	1	
Teopod × Normal sib		17	5	
Total		35	34	
Open-pollinated Teopod -1		20	15	1
-2		19	15	
-3		5	14	2
-4		19	19	1
-5		10	15	2
-6		15	14	
-7		10	11	
-8		18	16	
-9		14	18	
-10		9	12	1
Sub-total		139	149	7
Grand total		174	183	7
Expected		182	182	

HEREDITARY IMPAIRMENT OF HEARING

FRED DE LAND

CORRECT answers to three questions should be of interest to the increasing numbers of families that desire to successfully control the tendency they appear to possess of transmitting to offspring a characteristic or a "something" that is apt to develop or result in an impairment of the sense of hearing. These questions are:

1. From what ancestral cause originally came "family deafness?"
2. Why do the three sense defects, deafness, blindness, idiocy, apparently arise from a "common cause?"
3. What is that common cause?

Fifty years ago Alexander Graham Bell sought the clue to the particular selective influence that led so many among the deaf to marry the deaf and thus to aid in increasing the number of deaf-born offspring. In turn this led him to seek the prime factor that might aid in determining the probability of offspring with impaired hearing resulting from a mating of the deaf with the deaf. Finding that factor, he sought for the fundamental cause of hereditary deafness.

In 1883 at the New Haven meeting of the National Academy of Sciences, he delivered an address[1] in which he expressed the belief that the selective influence that led the deaf to mate with the deaf, was the unwise manner in which the social environment of a majority of deaf children was changed during the entire institutional school-period. In his own words: "Segregation really lies at the root of the whole matter; for from this the other causes have themselves been evolved by the operation of the natural law of adaptation to environment."

Also, he believed that the essential factor in determining the probability of deaf offspring likely to result from a contemplated marriage, was not the degree of deafness in one or both of the mates, but whether there *were deaf relatives on either side,* even if one of the prospective mates was a hearing person.

Dr. Bell continued his researches, and the deeper he delved the more important was the part that heredity appeared to play in the production of deaf offspring. In February, 1885, he wrote to the editor of *Science* that he had analyzed the 1880 Census returns of defectives, and stated[2] that "the apparent correlation between deafness, blindness, and idiocy may possibly indicate that in a certain proportion of cases, these defects arise from a common cause, perhaps arrested development of the nervous system."

In 1885, and[3] again in 1886,[4] Dr. Bell addressed the National Academy of Sciences, and explained the progress he was making in his researches concerning the essential factors involved in the production of "family deafness;" and in collecting ancestral records of certain New England families in which an inherited tendency to impairment of hearing was particularly noticeable. He exhibited genealogical charts of these families showing the ancestors from whom the inheritance may have come. (Incidentally, it may be stated that he was the first to employ trained genealogists to secure ancestral records to aid in solving problems in human heredity.) He believed[5] that "if we could obtain a detailed account of the families of the ancestors of a large number of unrelated deaf-mute families, we might hope to throw light upon the origin of deafness by a *comparison of the genealogies;* whatever abnormal peculiarities the genealogies might present *in common* would probably have something to do with the production of the deafness." He realized the magnitude of the task

he had undertaken, and hoped that others would join in the good work.

In 1888 he was invited to aid the Royal Commission of Great Britain in solving certain problems relating to the deaf. In reply to questions asked by the members, Dr. Bell[6] said: "There is an undoubted correlation between blindness and deafness and idiocy. . . . I say that these three things probably have some cause. . . . I find that it is not uncommon for deaf-mutes, especially where they belong to a family having a number of deaf-mutes to have cousins, not brothers and sisters, who are idiots; as if the defect had struck down in one branch (of the family) as deafness, and in the other as idiocy. . . . There is one other point associated with congenital deafness, and that is, variability. . . . All round the point where the deafness occurs you find evidence of something generally affecting the nervous system in connection with the brain. . . . There is a case I have in which seven children are deaf-mutes. There was no deafness in the ancestors that was known, and no consanguineous marriage. But in this case one of these seven deaf-mutes married his first cousin and had a number of children who could all hear and speak, but three of them were feeble-minded. There again is something to indicate that the thing intensified might be in the brain and not in the ears at all."

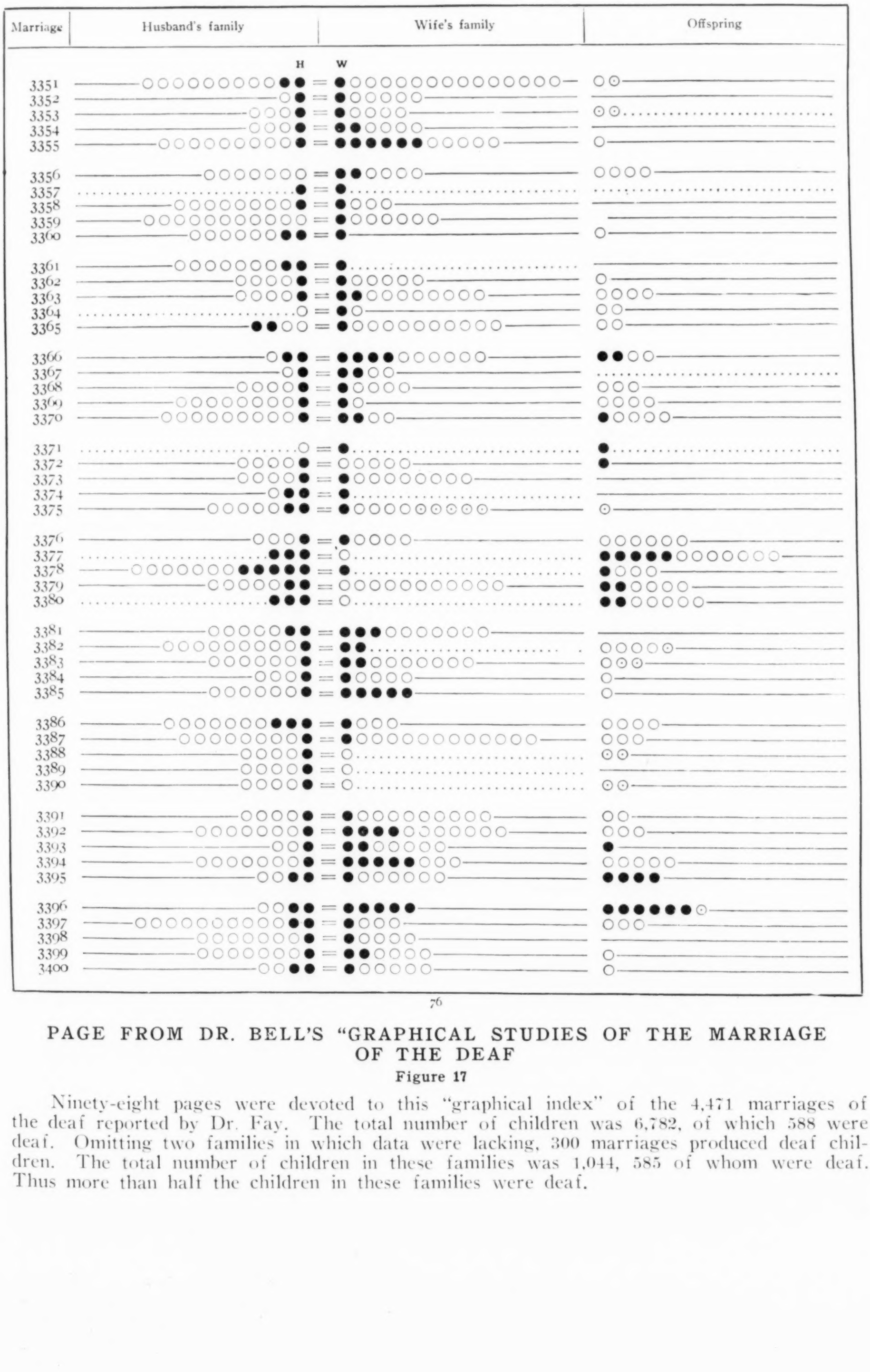
It was only natural that some among the deaf, and even some among their instructors, should jump to the conclusion that Dr. Bell's views were erroneuos. Yet none was able to find supporting evidence. Finally Professor E. A. Fay of Gallaudent College, volunteered to collect authoritive information that might prove that Dr. Bell's conclusions were wrong. During more than six years Dr. Fay devoted all his leisure time to collecting authoritative information concerning the family histories of more than seven thousand deaf persons or hearing persons married to deaf persons. In Dr. Fay's words: "The result of the whole effort is a collection of records of marriages of the deaf far larger than all previous collections put together; records, moreover, which, notwithstanding many defects, are believed to be trustworthy in their essential features, and which contain an immense quantity of valuable statistical information concerning the partners in marriage, their children, parents, brothers and sisters, and other relatives." After systematically arranging, analyzing and studying this vast fund of information, Dr. Fay wrote:

"The statistics above given fully corroborate Dr. Bell's conclusion that 'a heritary tendency towards deafness, as indicated by the possession of deaf relatives, is a most important element in determining the production of deaf offspring,' and that 'it may even be a more important element than the mere fact of congenital deafness in one or both of the parents' . . . The fallacy in applying to marriage of the deaf the law of heredity concerning the results of the union of 'like with like' lies, I believe, not in the direction suggested by Mr. Sedgwick, but in the erroneous assumption, made by nearly all the writers who have discussed this subject, that, when the deafness of the parent reappears in the offspring, deafness is the characteristic transmitted. As has already been stated, what is really transmitted is not deafness, but some anomaly of the auditory organs or of the nervous system, or the tendency to some disease, of which deafness is but the result or the symptom."

The value for research purposes of this information relating to families of the deaf, collected by Dr. Fay, justified the Volta Bureau in publishing in 1898, the results of Dr. Fay's studies in a volume bearing the title *Marriages of the Deaf in America.*

Then all the information collected was placed in Dr. Bell's hands for further study, which resulted in the book *Graphical Studies of Marriages of the Deaf,* which he published in 1917[8]. The thorough manner in which Dr. Bell analyzed the information sup-

GRAPHICAL INDEX TO FAY'S "MARRIAGES OF THE DEAF IN AMERICA."



76

PAGE FROM DR. BELL'S "GRAPHICAL STUDIES OF THE MARRIAGE OF THE DEAF

Figure 17

Ninety-eight pages were devoted to this "graphical index" of the 4,471 marriages of the deaf reported by Dr. Fay. The total number of children was 6,782, of which 588 were deaf. Omitting two families in which data were lacking, 300 marriages produced deaf children. The total number of children in these families was 1,044, 585 of whom were deaf. Thus more than half the children in these families were deaf.

plied by or about each family, may be inferred from the following incident. In one of the marriages reported by Dr. Fay, the husband was recorded as *deaf,* the wife as *hearing;* both were the only children in their respective families; and there were no known deaf relatives. Three hearing children were born of this marriage, but the first-born lost hearing when about the same age as the father who had lost hearing at four years of age. On the face of the published records the loss of hearing of the father and his child might be properly classified as "*acquired.*" But Dr. Bell was not classifying. He had one of his expert genealogists trace the ancestral history and found that an ancestor on the father's side has lost his hearing.

What is the true explanation of this case, as here stated? (The only text in Dr. Bell's graphical studies, aside from titles and headings is found in the brief explanatory introduction to the work as a whole). Did heredity play any part in the case cited? Was an inheritance transmitted in the form of a defective or undeveloped nervous system that lacked the vitality necessary to successfully resist the ravages of the "fever" that was reported to be the cause of loss of hearing in both father and child?

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A BIOMETRICAL MISCELLANY

A Review

STUDIES IN HUMAN BIOLOGY, by RAYMOND PEARL, Professor of Biometry and Vital Statistics, Johns Hopkins University. Pp. 653. Price $8.00. Williams & Wilkins Co., Baltimore, Md., 1924.

With the exception of three of the twenty-five chapters, this book is essentially a reprint of articles published by the author in widely scattered technical journals during the past twenty years. As the title implies, the book covers a wide range of biometrical studies in human biology with little attempt at unity, though an effort has been made to group the related subjects in four main divisions. The difficulties involved in attempting continuity can be appreciated when it is realized that the book includes such diverse subjects as Mortality and Evolution, Biology and War, the Growth of Human Populations, the Sex Ratio among the Jews, and Food Waste, to enumerate only five of the twenty-five chapters.

While the lack of unity is unfortunate from the standpoint of the general reader, the book is essentially a reference work where those seeking accurate information on human biology can consult Dr. Pearl's valuable contributions to this subject. From this standpoint it is to be regretted that the exigencies of space precluded the publication of all the data which appeared in the original essays.

To those who have followed the original articles as they appeared, the clearly-stated conclusions often so strikingly at variance with commonly accepted opinions are no longer a novelty; but to those who have neglected the original papers, such conclusions as the following taken almost at random from the various chapters should serve as a stimulus to read the collected essays:

There is no evidence that brain weight is sensibly correlated with intellectual ability. With advancing age there is a steady decline in the weight of the brain, beginning at about the twentieth year and continuing throughout life.

The proportion of male to female births is greater where the parents are of different racial stocks than where they are of the same.

Native white populations seem generally to be in a period of biologic improvement, while foreign born whites are, on the contrary, displaying progressively less biological vigor.

After age 40 to 45 it appears that man shortens his life, by definite amounts, in proportion as he performs physically heavy labor.

The parents of cancerous and tuberculous individuals die at an age from two to four years earlier than those of non-tuberculous or non-cancerous individuals, from which it follows that both the tuberculous and the cancerous are of weaker stock constitutionally than those not having these diseases.

Rural populations were slightly, but probably not significantly, less damaged, in a biological sense, than urban populations, by the influenza pandemic, while the foreign population was definitely harder hit by the pandemic than the native.

A certain number of children are born with variations which are unfavorable to the procedure of normal physiological processes, and, if their mortality curve is considered, it is inconceivable how any one can say that natural selection in one form or another is not acting on man at the present time.

Nations neither lose nor gain biologically by war, since the agents of destruction chiefly relied on in present conflicts are entirely impersonal and distribute their effects largely at random. Wars will occur in the future

as they have in the past until such time as civilized man has become a different kind of animal than he now is.

And finally, it is to be hoped that all social workers and other amateur statisticians will read chapter XX on the Statistical Evaluation of Public Health Activities, which it seems to the reviewer might well have been the introductory chapter. *J. H. K.*

Plant Histologist's Handbook

METHODS IN PLANT HISTOLOGY by PROFESSOR CHARLES J. CHAMBERLAIN. 4th ed., revised, pp. 349, with 118 illustrations. Price $3.25. The University of Chicago Press, Chicago. 1924.

Dr. Chamberlain has revised again his "Methods in Plant Histology." After a period of ten years of advancement in Botanical research this widely used handbook has been rewritten and shows many minor and some major changes in text and text figures, both serving to bring the book up to date.

Students of unicellular and filamentus plant forms and of delicate plant tissues will find that the Venetian turpentine method has been painstakingly described. The author frequently advocates this method of mounting in place of the older glycerine and glycerine jelly methods.

The concluding statement of the chapter on the celloidin method, "when material is to be imbedded, use celloidin when you *must,*" seems unjust. Many histologists are using celloidin, not as a last resort, but as a satisfactory medium for imbedding a great variety of plant tissues. The reviewer has used celloidin even for imbedding cytological material of young tomentose buds of Fragaria where paraffin failed.

Those interested in a new method of preparing hard woody tissues for the microtome will find a few pages in which the cellulose acetate method for softening refractory tissues is described. This method may prove extremely valuable but is still in the experimental stage of development.

All botanists will feel more confidence in the stains produced from American factories after reading in this book that a few of our stains are even superior to those of foreign manufacture. The use of American stains has only recently given satisfactory results. The confidence of histologists in our local products is being won through the efforts of such men as Dr. Chamberlain and the reports of our Committee on the Standardization of Biological Stains.

Dr. Chamberlain has attempted in his chapter on Photomicrographs and Lantern Slides to explain the principles of this art. Through these directions and the help of pamphlets he cites, it is to be hoped that photomicrography will pass from the specialist in this art and become more generally used in the research laboratories.

A final addition and one that is looked for in modern scientific books is the Bibliography, which, although not extensive, will be a valuable nucleus for future growth.

A. E. L.

SELECTION OF SWEET POTATOES

E. A. Stokdyk
Kansas State Agricultural College

THE relation of seed type and environment to type in both Irish and sweet potatoes has been a question of special interest to everyone who has been working on the improvement of stocks through hill selection. It has been a common practice to choose the hills for seed that show the desired type, providing, of course, that they are free from disease. It has been assumed that the type will be transmitted in future propagations. Krantz worked with Irish potatoes, planting various types under different soil and climatic conditions, and states that on a given soil under given climatic conditions the tubers produced were nearly identical in type.

Little or no data are available at the present time regarding the influence of environment on type in sweet potatoes. The evidence presented herewith may, therefore, be of interest to those using the hill selection method for seed stock improvement.

Kansas-grown sweet potatoes are, as a rule, long and stringy in type. The reason for this appears to lie in two factors. First, the soils are loose and deep, which allows the roots to grow deep and long. Second, the growers have made a practice of gathering the strings thrown out of the table stock for seed. Our original seed stock, as far as can be traced, came from New Jersey, and it is a common observation among growers that the seed "runs out" after being planted in Kansas for a few years. That is, the roots lose their short, blocky type and become stringy. The New Jersey stock is grown on a very different type of soil. There the surface soil is shallow and the subsoil is hard, which prevents the roots from going deep. This produces a short, blocky type of potato which is in demand on the market because of its value as a baking potato. Kansas growers are desirous of producing this type of potato, and in their efforts to do so have used two methods: (1) hill selection and (2) propagation of stocks from New Jersey. Those who have practiced the latter method state that these stocks produce the blocky type for a time but lose it in a few years. Experiments were, therefore, conducted to throw some light on this question. On the farm of C. M. Smith, at Rossville, Kansas, stocks were planted as follows:

1. Seed direct from New Jersey.
2. Seed grown in Kansas one year from New Jersey stock.
3. Seed grown in Kansas several years and originally from New Jersey stock.

At harvest time type samples of the roots produced by each of the above lots of seed were chosen by (a) the writer, (b) the county farm agent, and (c) the grower. Photographs were taken of these samples as shown in figure 18. From this it is evident that the blocky type shown by the New Jersey stock is transmitted to the first and second propagation, but that it is lost after several propagations.

On the farm of A. R. Tiffany stocks were planted as follows:

2. Seed grown in Kansas for one year from New Jersey stock.
3. Seed grown in Kansas two years from New Jersey stock.
4. Seed grown in Kansas several years orginally from New Jersey stock.

Figure 19 shows the type produced by each of these lots of seed. It is again

"Seed" direct from New Jersey

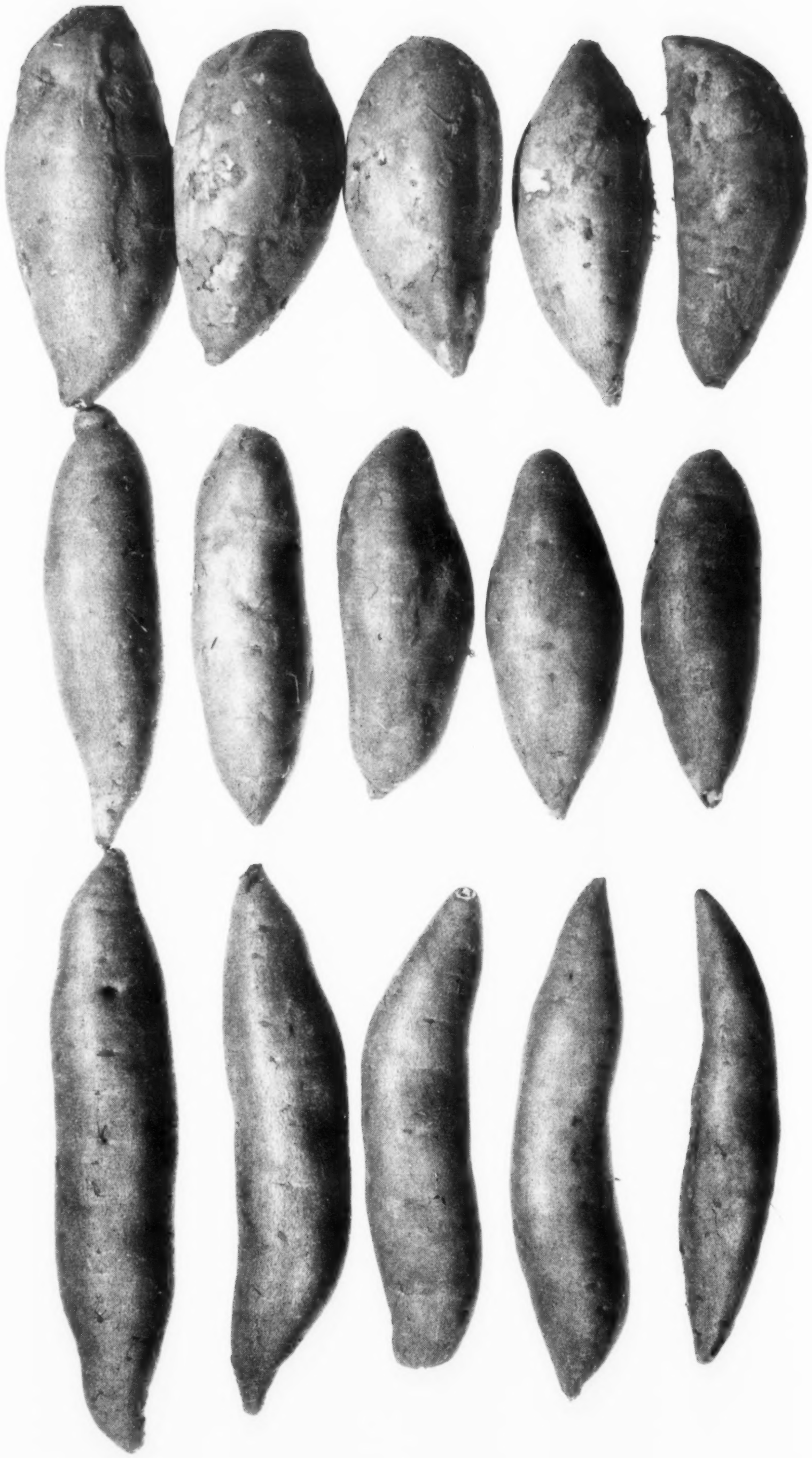
"Seed" grown in Kansas one year from New Jersey Stock

"Seed" grown in Kansas several years

EFFECT OF ENVIRONMENT ON TYPE OF ROOT

Figure 18

When grown from New Jersey raised "seed" the roots are of the desired blocky type, which is lost after several years of propagation in Kansas.



"Seed" grown in Kansas one year from New Jersey Stock

"Seed" grown in Kansas two years from New Jersey Stock

"Seed" grown in Kansas several years

KANSAS GROWN SWEET POTATOES

Figure 19

The blocky type of root persists for one or two propagations and then is lost.

evident that the second propagation (2) produced from seed grown in Kansas one year inherits the blocky type. However, by the third year (3) there is a considerable loss of blocky type, but the blocky character is retained to some extent. Lot No. 4, which was produced by stock propagated several times, has lost all of its blocky character and is typical of the Kansas stringy roots.

From this evidence it would appear that type characters in sweet potatoes are transmitted in the first and second propagation, but are not readily transmitted in the third and following propagations.

An experiment to study the influence of selection on type of potato produced has been under way for four years on the farm of Charles Speaker at Kansas City, Kansas. He has been hill-selecting for blocky type. That is, he has picked the hills for seed that produce the short, chunky type of root. In comparison with his selected seed he has grown stock that has not been hill-selected. At harvest time records were taken on the two lots of seed, but no difference in type was noted.

It would appear, then, that environment is a very important factor in determining the type of sweet potato produced in Kansas. It is recognized, however, that in this, as in other instances, account must be taken of both environmental and hereditary factors.

From a practical standpoint it appears, from the limited data at hand, that Kansas growers will be highly repaid for sending to New Jersey each year or two for seed of blocky type.

Restrictions on Mating

MEDICAL CERTIFICATION FOR MARRIAGE, by Fred S. Hall. Pp. 92. Price 50c. New York, Russell Sage Foundation, 1925.

Wisconsin's famous "eugenics law" (falsely so called) is the object of this study. Briefly, the law provides that no marriage license may be issued unless the male applicant presents a physician's certificate showing that he is free from infection with any venereal disease. The law has been much criticized on the ground of carelessness and fraud on the part of physicians, on the ground that women are not examined, that false assurance of safety is given them, on the ground that the law is easily evaded, and so on. Mr. Hall goes thoroughly into the actual results of its operation and concludes that, on the whole, it has done good, but that some administrative modifications in it are needed. The law is, of course, hygienic in purpose, and its relation to eugenics is remote, in spite of its popular name. *P. P.*

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